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THE PREPYLORIC CONTRACTIONS IN CERTAIN ABNORMAL CONDITIONS

by

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In a previous article (KEET 1957) the prepyloric contractions were described in a series of 310 normal cases. It was seen that the roentgen features of the normal prepyloric contractions can be explained on the basis of the anatomy of the part as determined by FORSSELL (1913, 1934) and TORGERSEN (1942). In other words, the normal prepyloric contraction appears to be due to a contraction of the pyloric muscle knot on the lesser curve and the right and left pyloric muscle loops on the opposite greater curve. Together, these structures constitute the canalis egestorius or the 'pyloric muscular structure'.

The 310 normal cases formed part of a larger series of 700 routine barium meal examinations done over a two year period. In the present article an attempt will be made to classify the abnormalities in the remaining 390 abnormal cases, and to describe the prepyloric contractions in them.

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Spasm of prepyloric musculature without organic lesion elsewhere in oesophagus, stomach or duodenum (simple spasm)

A group of 52 cases showed essentially similar features. In none of these cases could an organic lesion be demonstrated in the oesophagus, stomach or duodenum but in all cases the prepyloric musculature failed to relax fully. While relaxation was never complete, full contraction was also reduced, and a maximal contraction occurred only occasionally. The musculature appeared to be permanently in a state of partial contraction.

The following case is an example:

Case 1. Female aged 18 years. A clearly defined area in the prepyloric region failed to relax throughout the examination. This area showed the following features on detail views: the division between stomach and duodenum on the lesser curve was markedly widened, while two contracted areas were seen on the opposite greater curve, viz. one in the division between stomach and duodenum, and the other some distance orally to this (Fig. 1). Minor variations occurred in the shape of the contracted area, but there was no essential change. There was no organic abnormality in the oesophagus, stomach or duodenum.

The significant feature is that the contracted area in this case conforms to a phase of the normal prepyloric contraction, viz. the inverted 'V' or pre-pseudodiverticular phase, as reference to the description of the normal cases will show. One concludes that the spasm in these cases is limited to a contraction of the pyloric muscle knot on the lesser curve and the right and left loops on the greater curve, *i. e.* the canalis egestorius.

The remaining cases in this group behaved in the same way. As no organic lesion could be found in the oesophagus, stomach or duodenum, they are called cases of simple spasm.

Antral gastritis and spasm

Antral gastritis and spasm is a condition recognized by various authorities, notably by Golden (1937). It is not our intention to discuss the role of radiology in the diagnosis of gastritis. Suffice it to say that the essential abnormalities in this condition are said to be: spasm of the gastric 'antrum' and the presence of large, irregular and transverse mucosal folds in the spastic area.

The following case may be quoted as an example:

Case 2. Female, aged 44 years. Barium meal showed a constant spasm of the prepyloric area, bounded on the lesser curve by a relatively wide division between stomach and duodenum, and on the greater curve by the division between stomach and duodenum and

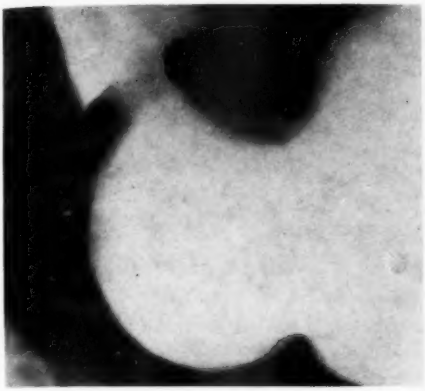

Fig. 1

Fig. 2

Fig. 1. Case 1. The division between stomach and duodenum on the lesser curve is markedly widened, due to a contraction of the pyloric muscle knot. On the opposite greater curve there is a contraction in the division between the stomach and duodenum, and another contraction some distance orally to this, due to contraction of the right and left pyloric loops. Case of simple spasm of the canalis egestorius.

Fig. 2. Case 2. The extent of spasm is identical to that in fig. 1. Large, transverse and irregular mucosal folds are seen in the spastic area. Case of antral gastritis and spasm.

a second impression some distance orally to this. The entire spastic area was more or less triangular in shape, with the apex of the triangle on the lesser curve and the base on the greater. Transverse and irregular mucosal folds were seen in the spastic area (Fig. 2). No organic abnormality was noted in the oesophagus, stomach or duodenum, and the diagnosis of antral gastritis and spasm was suggested.

Here again it is clear that the spasm is limited to the muscle knot and the right and left loops, together with the intervening musculature. It is not surprising to find transverse and irregular mucosal folds in the spastic area, as it will be recalled that normally the folds always run transversely or irregularly when the canalis egestorius is in a state of partial contraction, and only change to the longitudinal direction when the canalis contracts maximally (KEET 1957). Seeing that the canalis remains in a stage of partial contraction more or less permanently in these cases, one does not expect longitudinal folds.

Comparison with the normal cases will show that the appearance shown in Fig. 2 is identical to a phase of the normal contraction — the only difference being that in the normal contraction it is a fleeting stage, while in these cases it illustrates a permanent contraction.

Seeing that the radiological character of the spasm is identical in simple spasm and 'antral gastritis and spasm', we include all these cases in the first group of 52 cases.

Spasm of prepyloric musculature with organic lesion in stomach or in duodenum

A further group of 44 cases showed a similar type of spasm in the presence of an organic lesion in other parts of the stomach than the prepyloric area or in the duodenum. This group is made up as follows (the number of cases showing normal prepyloric contractions is given in brackets): 21 cases of ulcer on the lesser curve away from the prepyloric area (normal prepyloric contractions in 24 cases), 17 cases of duodenal ulcer and duodenal deformity (138 normal), 4 cases of carcinoma of the fundus and body of the stomach (16 normal), 2 cases of hiatus hernia (11 oesophageal varices and hiatus hernia cases normal).

The following are examples of the spasm:

Case 3. Male aged 40 years. Barium meal showed a large ulcer high up on the lesser curve. The prepyloric musculature was constantly spastic, the features being identical to those described under simple spasm. The spasm of the left pyloric loop is particularly well seen on films of the full stomach (Fig. 3).

Case 4. Male aged 54 years. Barium meal on 21 June 1954 showed a large ulcer on the middle of the lesser curve. There was an associated constant spasm of the canalis egestorius, consisting of a contraction of the pyloric muscle knot (causing a widening of the division between stomach and duodenum on the lesser curve), and a partial contraction of the right and left pyloric loops on the greater curve (Fig. 4).

A repeat examination three days later showed identical features. A third examination three weeks later after medical treatment showed that the ulcer had become smaller. The spasm of the pyloric musculature had disappeared and the prepyloric contractions were perfectly normal.

At operation on 16 July 1954 an active, chronic ulcer was found on the middle of the lesser curve. Macroscopically and microscopically the prepyloric area was normal, proving that the prepyloric contraction seen during the first two barium meals was of a spastic nature.

LILJA (1953) pointed out that it has long been recognized that ulceration of the stomach may give rise to organic and functional changes other than those produced by the ulcer crater. In ulceration of the incisura angularis, WARMOES (1950) described changes in the pyloric antrum, and LILJA remarked that in these cases the appearance of the canalis frequently deviates from the normal. He suggested that a disturbance may occur in the canalis in cases of ulceration of the incisura, and, although such changes had been observed before, their cause had not been understood.

In further work on ulceration of the incisura, LILJA (1954) stated that it was frequently possible to demonstrate an abnormal contraction of the canalis in such cases. Often a permanent contraction of the canalis was seen, which sometimes resembled the appearances of pyloric stenosis in children. At times, however, a non-characteristic functional impairment

Fig. 3

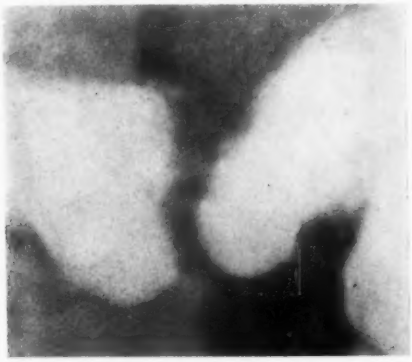

Fig. 4

Fig. 3. Case 3. Large gastric ulcer high on the lesser curve. The spasm of the left pyloric loop is well seen.

Fig. 4. Case 4. The pyloric muscle knot on the lesser curve, the right and left loops on the opposite greater curve and the intervening musculature are contracted.

of the canalis could be observed. Sometimes there were prepyloric contractions, which had been variously interpreted, but which could still not be satisfactorily explained.

The present group of cases shows that spasm of the canalis egestorius may occur in cases in which organic pathology is found in the stomach away from the prepyloric area, or in the duodenum.

In these cases it was possible to explain the prepyloric contractions on the basis of contraction of the constituent parts of the canalis.

Spasm of prepyloric musculature associated with prepyloric ulcer

In a further group of 32 cases, the diagnosis of pyloric ulcer was made. In all of these a niche was seen in the prepyloric area. Only in 3 of these cases the prepyloric contractions were normal. In the remaining 29 cases, a spasm or contraction of the canalis egestorius was seen. Approximately half of these cases came to operation, at which the diagnosis was verified. The following case is an example of those operatively controlled:

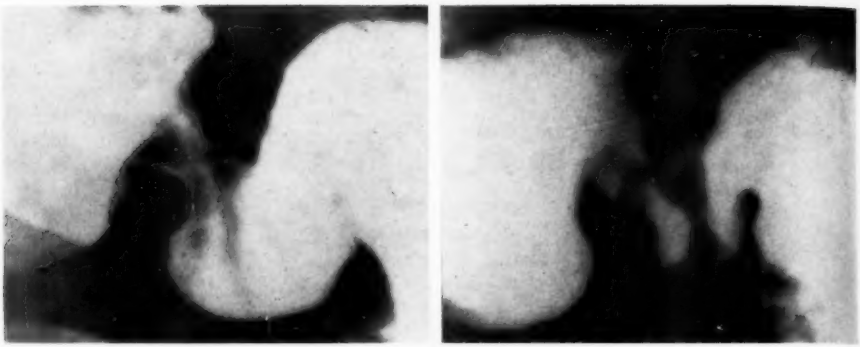

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Fig. 5. Case 5. a) The muscle knot on the lesser curve, and the right and left loops on the greater curve, with the musculature in between, are contracted. Tiny niche in the contracted area, not well seen on this film. b) The spastic area remains essentially unchanged. Large, transverse mucosal folds stretch into the pseudo-diverticulum.

Case 5. Male aged 58 years. Barium meal showed a persistent spasm of the canalis egestorius. The division between stomach and duodenum on the lesser curve was constantly widened, due to contraction of the pyloric muscle knot. On the greater curve the right and left loops and the musculature between them were constantly contracted (Fig. 5a). Compression views of this area showed a tiny ulcer niche within the confines of the contracted area. Incomplete contraction and relaxation of this area occurred occasionally, but relaxation was never complete and the appearances remained essentially as illustrated. The diagnosis of prepyloric ulcer and spasm of the canalis egestorius was made.

Repeat examination a month later, after medical treatment, showed essentially similar features. Large transverse mucosal folds could now be demonstrated in the contracted canalis egestorius, stretching into the pseudodiverticulum (Fig. 5b). The small ulcer niche was again visible (not clearly seen in the illustration).

Operation three weeks after the second examination revealed a small, active pyloric ulcer. There was no evidence of malignancy. The duodenum, biliary system, pancreas and spleen were normal.

From these cases it may be concluded that a prepyloric ulcer may present as a spasm of the canalis egestorius. The ulcer itself may be very small, as in Case 5, and it may easily be overlooked. It is only the presence of the niche itself which differentiates these cases from antral gastritis and spasm and simple spasm.

Large, irregular mucosal folds in the spastic area may hamper the search. If barium collects in a crossing of two mucosal furrows a pseudoniche may be produced. A second or third examination may be necessary to determine if a constant ulcer niche is present.

Where the ulcer is large, of course, the diagnosis should be straightforward.

Fig. 6. Case 6. A large, constant niche is present on the lesser curve close to the pyloric orifice, and a smaller on the opposite greater curve. The niches are surrounded by a constant zone of contraction which does not conform to any stage of the normal pyloric contraction.

Not all pyloric ulcers present with a clearcut spasm of the canalis. It is our impression that these are usually large ulcers, situated close to the pyloric orifice. These ulcers probably extend deeply into the gastric wall and are surrounded by a mass of inflammatory tissue, causing a gross alteration of the anatomical and functional characters of the region. These ulcers therefore appear to be surrounded by a constant zone of contraction which cannot be explained on an anatomical basis. The following case is an example:

Case 6. Male aged approximately 63 years. Barium meal showed two large, constant niches in the prepyloric area of the stomach, one on the lesser and the other on the greater curve (Fig. 6). Both niches were surrounded by a constant zone of contraction approximately 1 cm in width. Regular peristaltic waves proceeded up to the contracted area, which remained unchanging in appearance. There was a total absence of normal prepyloric contractions, and the contracted area did not correspond to a phase of the normal prepyloric cycle. (The patient refused operation, and thus it was not possible to determine if the niches represented simple or malignant ulceration.)

Pylorospasm

This appears to be an opportune stage to discuss the question of pylorospasm. It may well be asked what is understood by pylorospasm. TEMPLETON (1947) defined it as a spasm of the pylorus and distal part of the antrum, and on another occasion as 'a contraction of the pyloric area'. BUCKSTEIN (1948) recognizes two spastic conditions under the heading of pylorospasm, viz.: a spasm limited to the pyloric orifice, and a spasm confined to the pars pylorica. GOLDEN (1951), and SHANKS and KERLEY (1950), similarly differentiate between a spasm of the pyloric orifice and a spasm of the antrum. None of these authorities described the features of spasm of the 'antrum' in detail, neither have they sketched its anatomical background.

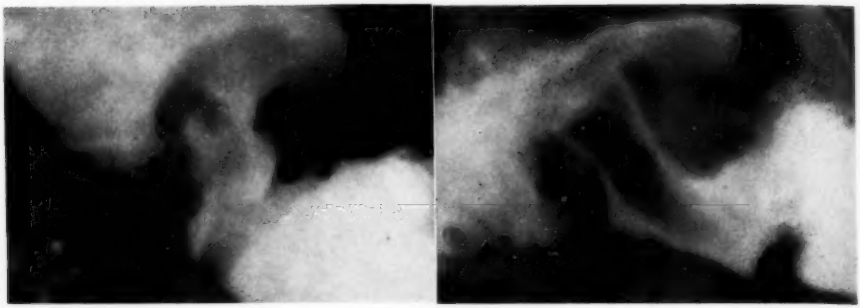

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Fig. 7. Case 7. a) Bizarre, constant, irregular contraction in the prepyloric region. There is a constant concavity of the base of the bulb. b) A month later. The muscle knot on the lesser curve, the right and left loops on the greater curve and the intervening musculature are contracted. The base of the bulb shows a constant concavity. A single longitudinal mucosal fold is seen in the pyloric canal.

It appears as if the four essentially similar types of spasm elucidated before, viz. simple spasm, antral gastritis and spasm, spasm associated with organic lesions elsewhere in the stomach or in the duodenum, and spasm secondary to a pyloric ulcer, conform to the 'antral' type of spasm which these authors had in mind. It has been shown above that the spasm in these four groups of cases is limited to the canalis egestorius, and it seems reasonable to call spasm of the canalis a type of pylorospasm. TORGERSEN originally thought that the canalis may be liable to undergo spasm. In our opinion the above cases confirm this theory. Spasm of the canalis is a well-defined entity, based on a clearcut anatomical background. Whether spasm of the pyloric orifice alone exists, is a different matter, which falls outside the scope of the present investigation.

The difficulty which may be encountered in the interpretation of bizarre prepyloric lesions in this connection, may be illustrated by the following case:

Case 7. A middle-aged male. Barium meal showed a constant contraction in the prepyloric area. The area of contraction was wider on the greater curve than on the lesser, its borders were irregular, and it contained large, transverse and irregular mucosal folds. There was, in addition, a constant concavity of the base of the duodenal bulb (Fig. 7a). No ulcer niche was seen.

A repeat examination a month later revealed the following features: a marked contraction of the pyloric muscle knot on the lesser curve, contraction of the left pyloric loop and the musculature between the left and right loops on the greater curve, a semicircular indentation of the base of the bulb, and a single, longitudinal mucosal fold in the almost fully formed pyloric canal (Fig. 7b). Careful search failed to reveal an ulcer niche. The features at the second examination showed that it was a case of spasm of the canalis egestorius. The concave indentation of the base of the bulb is presumably due to an in-

vagination by the spastic pyloric musculature. In the discussion of the normal cases we have seen that such an indentation may occur normally while the canalis egestorius is contracting (KEET 1957). When it is in a state of partial contraction, owing to spasm, the indentation thus would not be unexpected. In our spastic cases it was infrequently seen, however, and it is not a feature of all cases of spasticity of the prepyloric musculature.

A concave indentation of the base of the bulb has been described by KIRKLIN and HARRIS (1933) as a sign of hypertrophy of the pyloric musculature in adults. In this condition the causative mechanism is similar, viz. it is due to an invagination of the base of the bulb by the hypertrophied pyloric musculature (see below).

The appearances shown in Fig. 7b resemble a stage in the normal prepyloric cycle, but cannot be regarded as normal as they were constantly present and not of a fleeting nature.

Hypertrophic pyloric stenosis in adults

In the present series we have not encountered any verified cases of hypertrophic pyloric stenosis in adults. The series also does not include any cases of infantile pyloric stenosis. One case which we propose to describe was diagnosed radiologically as hypertrophic pyloric stenosis in an adult, but the surgeon did not verify this at operation.

After studying the cases of hypertrophic pyloric stenosis presented by RUNSTRÖM (1939), TORGERSEN came to the conclusion that the muscular hypertrophy was limited to the canalis egestorius in these cases. He thought that the condition represented the pathological counterpart of a physiological stage of contraction, viz. the stage of maximal or near maximal contraction. If this view is correct, it means that one should be able to recognize the condition radiologically by the shape of the contracted area, as it would conform to a stage of the normal prepyloric contraction.

MCNAUGHT (1957) recently described certain features of five cases and stated that the muscular hypertrophy could be explained on the basis of TORGERSEN's anatomical findings.

The following two points are, in our opinion, additional evidence in favour of TORGERSEN's views:

1. A concave indentation of the base of the duodenal bulb, due to invagination by the pyloric musculature, may occur in hypertrophic pyloric stenosis (KIRKLIN and HARRIS) as well as normally during the stage of contraction of the canalis egestorius (KEET 1957).

2. It is widely accepted that longitudinal mucosal folds are usually seen in the contracted area in hypertrophic pyloric stenosis in adults. We

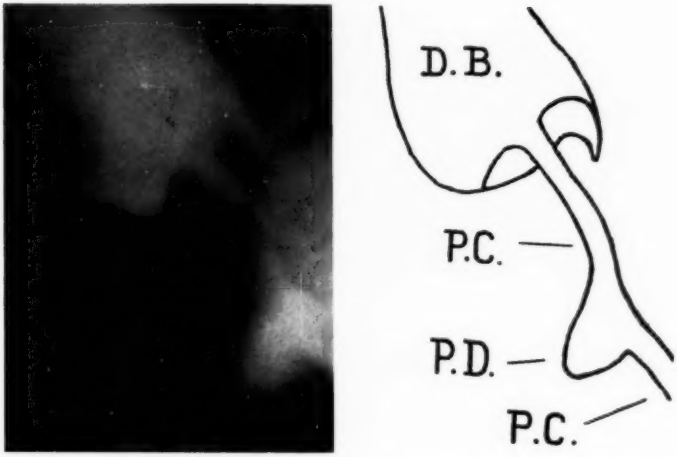

Fig. 8. Case 8. a) The pyloric canal is constantly formed, showing a pseudo-diverticulum on its greater curve side. There is a constant concavity of the base of the duodenal bulb. Possible case of adult hypertrophic pyloric stenosis. b) Tracing of (a). D. B. — duodenal bulb. P. C. — pyloric canal. P. D. — pseudo-diverticulum.

have shown that normally the folds also run longitudinally when the canalis contracts maximally (KEET 1957).

These two points show that certain radiological features of adult hypertrophic pyloric stenosis have their counterparts in the phase of maximal or near-maximal contraction of the normal prepyloric musculature.

The following case was diagnosed radiologically as hypertrophic pyloric stenosis in an adult:

Case 8. Male aged 70 years. Barium meal on 23 October 1953 showed a large, hypotonic stomach containing a considerable quantity of free fluid. An ulcer niche was present on the lesser curve some distance orally to a prepyloric contraction, showing the following features.

There was a long, constantly contracted canal, the distal half being of uniform calibre, smooth and devoid of peristalsis. The proximal half occasionally showed a lesser degree of contraction and dilatation, which once or twice resulted in the formation of a pseudo-diverticulum on the greater curve (Fig. 8). At other times the proximal half of the canal gradually tapered towards the distal half. Throughout the examination there was a constant concavity of the base of the duodenal bulb.

Peristalsis and emptying were delayed, and a large gastric residue was present after 6 hours. Because of the residue, it was felt that the contraction was too severe for a merely spastic phenomenon, and the diagnosis of an organic obstruction at the pylorus was made. Because of the occasional occurrence of a pseudo-diverticulum, the constant, smooth contraction of the distal half of the canal, and the constant concavity of the base of the bulb, it was concluded that the obstructing lesion had certain features similar to those of a

near-maximal normal contraction, and the abnormal contraction was thought, therefore, to be due to hypertrophic pyloric stenosis.

At operation on 26 November 1953 a chronic, benign gastric ulcer was found midway between the cardia and the pylorus. The duodenal cap was scarred, but showed no evidence of active ulceration. No mention is made in the operative notes on the condition of the pylorus. Radiologically the prepyloric area was grossly abnormal, and the question arises why the surgeon was not struck by this abnormality at operation. Is it possible that surgeons may not always recognize hypertrophy of the prepyloric musculature at operation? It is known that the thickness of the prepyloric musculature varies considerably in healthy adults, and it is conceivable, in our opinion, that hypertrophy of the pyloric musculature may be dismissed at operation as 'being within normal limits'.

While working in another country the author encountered a similar case. Radiologically the canalis egestorius showed a constant maximal contraction (indicating a radiological abnormality) with longitudinal mucosal folds in the contracted area, and a constant, concave defect of the base of the bulb. Because of the severity of the contraction and its persistence at two different examinations, it was concluded that it was not of a spastic nature but due to adult hypertrophic pyloric stenosis. There was also a large, sliding hiatus hernia. A senior surgeon operated and repaired the hiatus hernia, yet at direct palpation of the prepyloric area he stated that it felt 'normal' and did not consider that further exploration was warranted.

Looking back, one still considers that the radiological abnormalities described in these two cases were due to adult pyloric hypertrophy, with a small possibility that they were due to spasm only. While the alterations were not incompatible with spasm, they were, in our opinion, too severe for the latter, especially in Case 8, where there was a large 6-hour gastric residue.

Focal hypertrophy of pyloric musculature in adults

Recently two cases of focal hypertrophy of the prepyloric musculature in adults were described, the enlargement occurring in each instance on the lesser curve at the pyloric orifice (KEET 1956). Several similar cases have been described by BACHMANN (1952). In the majority of his cases, as well as in our two cases, the hypertrophy was located directly 'on top of', or astride, the pyloric orifice. In a minority of his cases, the hypertrophy occurred a short distance orally to the actual orifice (while still on the lesser curve). BACHMANN asked himself whether these cases meant that there was a specialized part of the pyloric musculature which, by virtue of its having a specialized structure or function, was liable to undergo hypertrophy. We believe that the answer is in the affirmative, as it is clear that in the majority of these cases the hypertrophy is limited

to the exact situation of the pyloric muscle knot. The conclusion has been that these cases represent a focal hypertrophy of the muscle knot.

BACHMANN, while apparently unacquainted with TORGERSEN's work, showed that the muscular hypertrophy may closely resemble an enlarged image of the normal pyloric musculature. Different degrees of muscular hypertrophy were encountered, and it is conceivable, therefore, that lesser degrees may be overlooked by pathologists. We believe that the same holds true for lesser degrees of 'generalized' adult hypertrophic pyloric stenosis, discussed under the previous heading.

Prolapse of gastric mucosa into duodenum

Widely divergent views have been expressed in the literature on the anatomical, radiological and clinical characteristics of prolapse of gastric mucosa into the duodenum. I have discussed most of these points elsewhere (KEET 1952) but find it necessary, in the scope of the present investigation, to draw attention to the following:

It is generally accepted that in many cases the defects in the base of the bulb, caused by the prolapsing mucosa, may be present at some times and absent at others, or more extensive at some times than at others. Most authors thought that the extent of prolapse depended on the position of the patient, some stating that it is better seen in the erect position (KÖHLER 1950), others that it was especially liable to occur in the horizontal position (COVE and CURPHEY 1949). NYGAARD and LEWITAN (1948) on the other hand, found that the duodenal defect changes its volume coincident with 'antral systole and diastole'. ZIMMER (1950) also noted that changes took place during peristaltic activity. FERMIN (1950) stated that prolapse seemed to disappear when peristalsis became less.

In this connection the following case seems worth quoting:

Case 9. A middle-aged male. There was no organic abnormality in the oesophagus or stomach. Gastric peristalsis and emptying were normal. The base of the duodenal bulb appeared quite normal while the canalis egestorius was relaxed or in a state of partial contraction (Fig. 9a). When the canalis contracted maximally, lobulated filling defects, caused by prolapsing gastric mucosa, were seen in the base of the bulb (Fig. 9b). The defects are continuous with mucosal folds stretching through the pyloric canal.

None of the 11 cases of prolapse and ten cases of prolapse with duodenal ulcer in the present series came to operation. However, several operatively verified cases which showed similar features to Case 9 have previously been described (KEET 1952). It appears that when the canalis egestorius contracts, the mucosa moves caudally instead of orally in these cases, that is, in a direction opposite to the normal. The mucosa is expelled

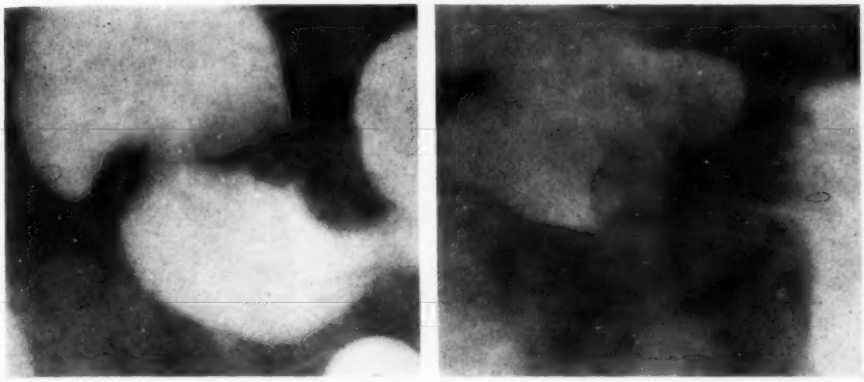

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Fig. 9. Case 9. a) The canalis egestorius is partially contracted. The base of the bulb is normal. b) A moment later. The canalis is maximally contracted. Lobulated defects of prolapsed gastric mucosa are now seen in the base of the bulb.

into the duodenum by the prepyloric muscular contraction in the same way as the gastric food contents are expelled. From this one concludes that the normal co-ordinating mechanism between the movements of the muscularis propria and the movements of the mucous membrane in the prepyloric area is lost or interrupted in these cases.

Other cases of prolapse occur, however, in which the duodenal defects are constantly present irrespective of the degree of contraction of the prepyloric muscular structure.

It appears, therefore, that two main varieties of prolapse may occur, viz. the 'temporary', in which a prepyloric contraction forces the mucosa into the duodenum, and the 'permanent', in which the mucosa is permanently extruded into the bulb.

It was seen (KEET 1957) that a concave defect of the base of the bulb is not necessarily due to either prolapse or to adult pyloric hypertrophy. It has been shown that similar defects may be seen normally, when the canalis egestorius contracts, or in spasm of the canalis. The essential difference is that in prolapse the defect occurs from within, and in normal cases, spasm and hypertrophy from without. A complicating factor is that prolapse may be associated with hypertrophy or fibrosis of the pyloric musculature (REES 1937). In such cases the radiological differentiation becomes difficult.

Pyloric carcinoma

It has been shown that a number of radiological abnormalities of the prepyloric area can be explained on the basis of the anatomical and functional peculiarities of this region.

Coming now to the question of pyloric carcinoma, one finds that here, as in most other situations, the lesion pays no heed to anatomical boundaries. Therefore, whenever a constant prepyloric contraction is seen which cannot be explained on the anatomical basis set out previously, carcinoma must be suspected. The following case will illustrate this point:

Fig. 10. Case 10. Constant, tapering constriction of the prepyloric region which does not resemble any phase of the normal prepyloric cycle. Case of pyloric carcinoma.

Case 10. Male aged 70 years. Barium meal showed a constant, tapering constriction of the prepyloric part, not conforming to any stage of the normal prepyloric contraction (Fig. 10). The diagnosis of infiltrative carcinoma was made. At operation three weeks later, a large pyloric adeno-carcinoma was found.

A prepyloric carcinoma may of course also present as an ulcer, and it has been shown previously that it is sometimes impossible to distinguish between simple and malignant ulceration on the basis of the prepyloric contractions. In those cases where a prepyloric carcinoma presents as a constant filling defect, the diagnosis should not be problematical.

In 4 cases of carcinoma of the fundus and body of the stomach there was an associated spasm of the canalis egestorius. Such a spasm, therefore, does not exclude malignancy elsewhere in the stomach. It is conceivable, too, that an early carcinomatous ulcer within the confines of the canalis may cause it to become spastic, although we have not yet encountered a case of this nature.

Unclassified and unexplained cases

A group of 32 cases remains in which the prepyloric contractions were not classified or could not be explained. The unclassified group comprises all cases of gastro-enterostomy, operative closure of duodenal ulcer, gross ascites and most cases in which more than one abnormality could be demonstrated in the oesophagus, stomach and duodenum. It was felt that

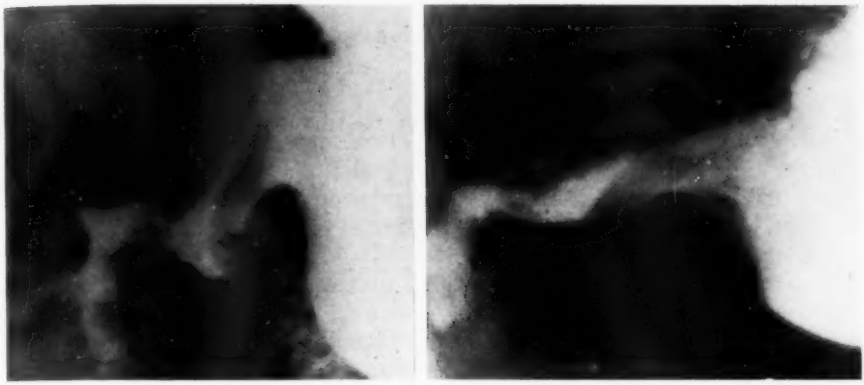

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Fig. 11. Case 11. a). Tapering, irregular constriction of the pyloric region which does not conform to any phase of the normal prepyloric contraction. Case of extensive adhesions and duodenal ulcer. b) A moment later a minor variation is seen in the contours of the contracted area. The normal anatomy of the pyloro-duodenal junction is grossly altered.

in these cases the prepyloric region might be deformed by operative suturing, external pressure, adhesions, etc, and an attempt at classification was therefore not made. There remains a small number of cases which were not explained. Several of these were cases of pyloric obstruction or deformity. As some of these did not come to operation or could not be adequately controlled, their discussion would not be of much value. The following is an example of one of the unexplained cases which did come to operation:

Case 11. Male aged 68 years. Barium meal on 16 February 1954 showed a constantly irregular, tapering prepyloric region devoid of regular contraction and relaxation. Minor variations in the contours of this area did occur from time to time (Fig. 11). The normal anatomy of the pyloroduodenal junction was grossly altered. The radiological diagnosis of infiltrating neoplasm of the prepyloric region was made. At operation on 19 February the greater omentum and duodenum were found adherent and fibrosed. The resection specimen showed a benign duodenal ulcer. Histological examination confirmed the absence of a malignant lesion in the stomach.

In this case the deformity was probably produced by extensive adhesions secondary to the duodenal ulcer. This and similar cases show that, while a proper understanding of the prepyloric anatomy is often a great aid in the interpretation of the radiological findings, a small minority of cases remains which cannot be readily explained.

Conclusions

It is shown that the canalis egestorius of FORSSELL and TORGERSEN, also called the prepyloric muscular structure, can become spastic, the pyloric muscular knot on the lesser curvature and the right and left pyloric loops of the greater curvature being contracted to a greater or lesser extent. Many apparently bizarre prepyloric contractions which have defied elucidation up to the present may thus be explained.

The spasm may be simple or be associated with prepyloric ulceration or disease elsewhere in the stomach or duodenum. Prepyloric ulceration frequently gives rise to spasm of the canalis, recognition of which fact may lead to the diagnosis of more prepyloric ulcers. The mucosal folds run transversely or irregularly, but not longitudinally, in the spastic area. The spastic musculature may cause a concave indentation of the base of the bulb of the duodenum. This is a type of pylorospasm which has a clear-cut anatomical background.

Additional points are advanced to support TORGERSEN's theory that hypertrophic pyloric stenosis in adults is confined to the canalis egestorius. Attention is drawn to recently described cases of local hypertrophy of the pyloric muscle knot.

The degree of prolapse of the gastric mucosa into the duodenum depends in the majority of cases on the degree of contraction of the canalis. The greater the contraction, the more extensive the prolapse. It appears as if the mucosa is expelled into the duodenum by the contraction, *i. e.* the co-ordination between the movements of the muscularis propria and the mucosa is lost.

Constricting carcinoma of the prepyloric area may often be recognized by the fact that it is not limited by the anatomic boundaries of the canalis egestorius. Carcinoma elsewhere in the stomach may produce a reflex spasm of the canalis but a constricting prepyloric carcinoma is unlikely to cause a typical canalis contraction.

SUMMARY

Cases in which the canalis egestorius of FORSSELL and of TORGERSEN was shown to be the site of spasm are reported and discussed. The anatomy of the region and the variations in the type of spasm in different processes of disease are described.

ZUSAMMENFASSUNG

Fälle, in denen der Canalis egestorius von FORSSELL und TORGERSEN nachweislich der Sitz eines Spasmus war, werden berichtet und diskutiert. Die Anatomie der Region und die Variationen der Spasmustypen bei verschiedenen Krankheitsprozessen werden beschrieben.

RÉSUMÉ

L'auteur présente et étudie des cas où on a constaté que le canalis egestorius de FORSSELL et de TORGERSEN était le siège de spasme. Il décrit l'anatomie de cette région et les variations du type de spasme dans diverses affections.

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TILT PHLEBOGRAPHY

A reliable method for diagnosing incompetent communicating veins

by

Frits R. Mathiesen

Increasing interest is being focused on incompetent communicating veins in the surgical treatment of varicose veins of the leg, and considerable importance must be attached to the finding of reliable methods for diagnosing and locating incompetence of the communicators.

The 'segmental Trendelenburg test' may yield good clinical information, and combined with a knowledge of the anatomy of the veins may locate incompetent communicators in a large percentage of cases; for various reasons, however, the results with this test are sometimes unreliable. A number of phlebographic techniques permit filling of the communicating veins, but there are no definite criteria as to whether or not the valves in these veins are competent. Moreover, there is no certainty that all incompetent communicators will be filled.

Retrograde phlebography fills the deep veins only when all valves are incompetent, and in such cases the valves in most of the communicating veins are also incompetent. On the other hand, if the valves in the deep veins are normal, the method affords no information regarding the communicators. MASSELL & ETTINGER (1948) have described a method

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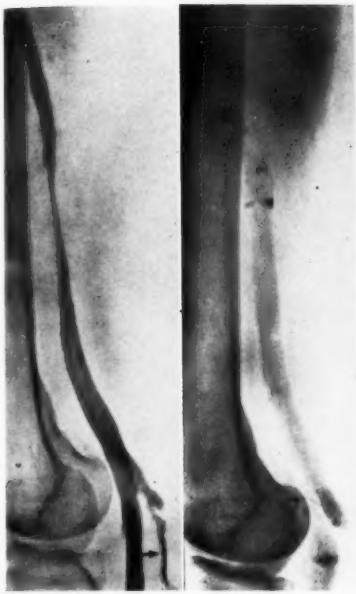
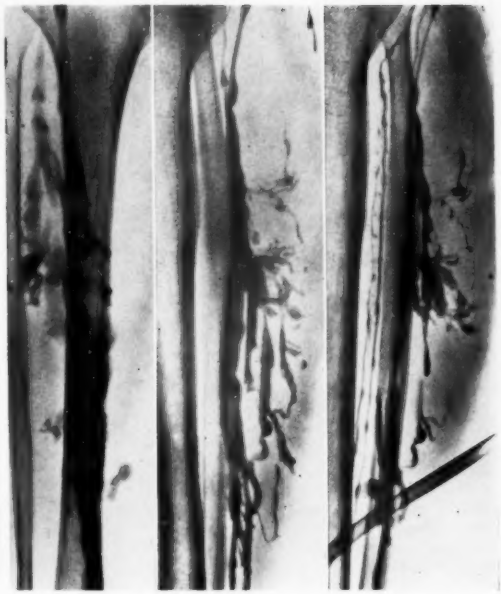


a b

Fig. 1. Lateral views of thigh. Comparison of phlebography, according to the method of MASSELL & ETTINGER (a), and tilt phlebography (b). Incompetent communicators demonstrated by the two methods. False incompetent communicator seen by M. & E.'s method was verified by tilt phlebography.

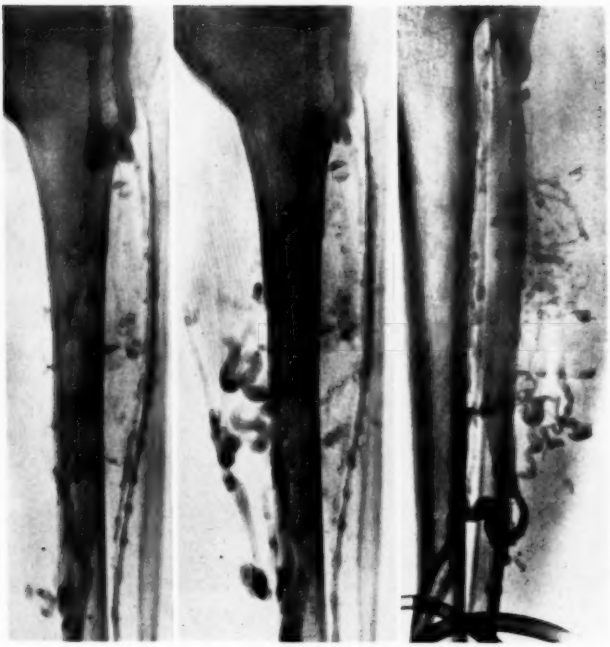


a b c

Fig. 2. Lower leg examined according to the method of M. & E. a) A. p. view. b) Lateral view (injection 40 sec/40 ml). c) Lateral view (injection 19 sec/40 ml). Rapid injection can fill the anterior tibial vein, whereas injection of the contrast medium at a rate of 40 sec/40 ml is unable to do so. One incompetent communicator is seen.

of ascending phlebography, the patient lying supine with tourniquets around the ankle, knee, and upper part of the thigh. If the ankle tourniquet is sufficiently tight, rapid injection of a contrast medium produces, in addition to a filling of the deep veins, an increased pressure in the deep but not in the superficial veins. The filling of the communicators must consequently have been retrograde. As shown by the present author (1955), however, the excess pressure obtained in the deep veins is only moderate, and retrograde filling may occur despite normal valves, whereas tilting to a vertical position produces such a change in the pressure that the normal valves will be closed during the first $^1/_2$ to 1 minute.

Fig. 1 a shows a retrograde filling in the poples which MASSELL & ETTINGER interpret as a sign of incompetence. Tilt phlebograms of the same leg (Fig. 1 b), however, disclose competent valves at the upper



a b c

Fig. 3. Tilt phlebography of the same leg as in figs. 1 and 2. a) A. p. view I of lower leg. b) A. p. view II. c) Lateral view. Now, four incompetent communicating veins are seen.

end of the small saphenous vein. The retrograde filling, seen with both techniques, must be explained by the fact that even the rapid injection of contrast medium in the horizontal position is unable to stop the centripetal flow of blood which keeps the valves open. The heavy contrast medium may consequently sink down, running against the direction of the blood flow despite normal valves. In addition, the tilt phlebograms (Fig. 1 b, and Fig. 3) show four incompetent communicators whereas phlebograms (Figs. 1 a and 2) taken by the technique of the above-mentioned workers can only disclose one with certainty.

SØRENSEN (1954) exposed the posterior tibial vein in the region of the internal malleolus and injected the deep veins directly. This presumably gives a somewhat higher excess pressure in the deep veins than MASSELL & ETTINGER's method and thus produces somewhat more reliable phlebograms. Nevertheless, the films reveal the weakness characteristic of phlebography in the supine position, *i. e.* filling is obtained

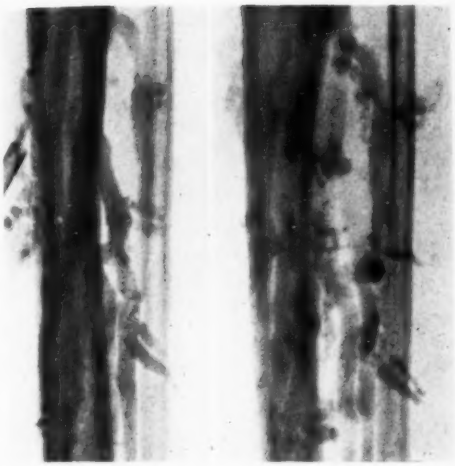


Fig. 4. Detail of the left lower leg from a patient with primary varices, to the left according to M. & E.'s method and to the right in a tilt phlebogram. On the lateral aspect there is a filling which in the former must be interpreted as incompetence of the communicators. In the tilt phlebogram nevertheless, all communicators concerned are seen to end in competent valves. It may be observed that with tilt phlebography the appearances might also have been interpreted erroneously, if only one film in each projection had been obtained.

Fig. 5. Patient after injection of the contrast medium before roentgenography. Overhead tube in front of patient, and dental tube used for lateral views to his right. Tourniquets above the malleoli and in the groin.

only of the most dependent parts. MOORE (1949) introduced the use of Valsalva's manoeuvre during the exposures. It may be used for phlebography in the supine position as well as for ascending phlebography and is well suited for demonstrating the valves in the deep veins, but hardly for deciding whether the communicators are incompetent. This can only be done by obtaining two sets of films with the valves closed (Fig. 4).

In MARTORELL's (1946) and DOW's (1951) techniques the contrast medium is injected in a central direction through the communicators, one at a time, and the question of incompetence is decided exclusively from their outlines, as the valves cannot be shown by this means. DOW pays special attention to the calibre of the communicators, particularly at their junction with the superficial veins.

The method described by DOHN is based on an entirely new principle. After injection of the contrast medium into the deep venous system, the patient is tilted from the supine to the erect position. If the great saphenous vein is compressed before the tilting, this actually amounts

to Trendelenburg's extended test simultaneously with the phlebography. This method must therefore afford the best opportunities for a reliable diagnosis of incompetent communicating veins.

Bearing Dohn's method in mind, we have tried to work out a technique likely to give the most reliable information regarding the state of the communicating veins. This modification of tilt phlebography was based upon the following considerations:

1. The injection must be performed rapidly, *i. e.* 40 ml of contrast medium injected within less than 20 (preferably about 10) sec. It is therefore necessary to apply a tourniquet above the malleoli and to use a stout venous needle (1.1 to 1.0 mm in diameter).

2. As soon as the vein has been punctured, the couch must be tilted to the horizontal position and temporarily fixed. Compression with cotton wool and elastic adhesive tape must be applied over the site of the puncture (and needle), so that after the injection the needle may be withdrawn without any risk of bleeding from the punctured site despite the tourniquet (Figs. 6 and 7). The loss of blood may be further restricted to a minimum by digital compression of the vein until the adhesive tape has been applied.

3. Two sets of films must always be obtained in the same projection in order to demonstrate the direction of the filling in the communicating veins in the erect posture.

4. The exposures must be made so swiftly that they are completed within half a minute after tilting. Unlike DOHN in his thrombosis technique we do not apply a compression bandage to the leg to be examined and we do not move the leg between the exposures.

5. A tourniquet must be applied around the thigh, close to the groin, just tight enough to compress the great saphenous vein, since reflux from this vein will cause interference in the films. (If the phlebography is performed without a tourniquet in the groin, *i. e.* as in the ordinary Trendelenburg test, a sufficiently rapid exposure may demonstrate any incompetence in the groin, although this is more easily performed and at least as reliable as the clinical method alone.)

With these modifications, tilt phlebography has been the routine method in our department since the spring of 1952 and has enabled us to obtain far better information regarding the deep veins and their functional capacity. The author's experience is based on 687 phlebographic examinations in 470 cases (including a series of 275 varicose cases most of which had 2 or more phlebographic investigations).

Of the 687 cases, 30 were normal and 34 had a history of deep thromboses. The remainder had primary varicosities, and in these the object of the investigation was to obtain further information about the state of the communicating veins.

We employed Diodone 35 %, an antihistamine substance being added to the first 20 ml injected in the hope of reducing the risk of allergic reactions. At the outset we used only 20 ml of contrast medium for each leg, but owing to the rapid injection, it was sometimes difficult to fill the entire deep venous system, especially in cases in which the deep

Fig. 6. Tilt phlebography of left leg with large incompetent communicating vein medially. Increased filling in the peripheral direction between the two exposures. (Lateral view not shown for lack of space.)

Fig. 7. Tilt phlebography of left thigh. Sequelae of deep thrombosis. Incompetent valves, irregular calibration, and muscular collaterals with a longitudinal course.

veins were of the large calibre usual in primary varices. The dose was consequently increased to 40 ml per limb. The larger dose has invariably produced good filling of the veins of the thigh as well as those of the leg beneath the knee; the iliac veins are also generally well shown as far as the inferior vena cava. The rapid injection produces intense opacity of the veins which are filled.

Results

All the patients were controlled for a few days after the phlebography. No serious complications have occurred to date in the 1,300 phlebographies performed, 687 of which were carried out by the author. Iodine allergy tests were not used.

One patient complained of malaise and had an evening temperature

of 38.5° C; there was some periocular swelling but the next morning all signs and symptoms had disappeared. The urine was negative for albumin, and there was no elevation of the blood urea. Another patient had a temperature of 38° C in the evening after the investigation but no other signs. Two patients developed urticaria immediately after the phlebography but this subsided in about 30 minutes.

Ten patients fainted before the contrast medium was injected but were able to continue the investigation. Several of them had phlebography of both legs. In these patients as well as in the elderly patients, however, caution was observed in not tilting the couch too suddenly to the upright position. No patient fainted after the investigation was completed. The tendency to faint was seen particularly in patients with large incompetent veins in the legs. In such instances, a tight bandage on the contralateral leg may be beneficial (WESTERGAARD-NIELSEN 1957).

Assessment of incompetence in the communicating veins. Regardless of the numerous anatomic variations, an accurate knowledge of the position and course of the deep veins is necessary (cf. HØJENSGAARD, inter alios, 1951). A correct assessment also presupposes a knowledge of the normal as well as the pathologic appearances of the communicators (RAIVIO 1948, SHERMAN 1949 et coll.). It is particularly important to bear in mind that the communicators in the thigh generally have a fairly long, oblique course, so that the perforation through the muscular fascia may be difficult to locate, whereas in the lower leg the communicators run a short course, at right angles to the deep veins. The technique described will demonstrate the communicators if they are incompetent, although at times some filling of normal communicators may also occur. As already mentioned, the explanation must be that during the injection in the horizontal position only a slight excess pressure is produced in the deep veins, so that a retrograde flow of the contrast medium takes place before the patient is tilted (cf. Figs. 1 to 4).

In cases of incompetence, the filling is seen to be increased in the direction from the deep to the superficial veins, or the varicose veins, between the two anteroposterior exposures. This does not occur when the valves in the communicating veins are competent. It is of decisive importance, therefore, to compare these two views. It is, moreover, a sine qua non for a reliable diagnosis to complete all exposures while the relative increase in pressure in the deep veins is sufficient to secure closure of all the normal valves in the deep veins and the communicators.

It is an advantage to note the times both of the rate of injection and the interval from the completion of tilting to the various exposures. The author took down the times of the first 200 phlebographies. Completing all exposures within 30 to 40 seconds after the tilting ought to secure reli-

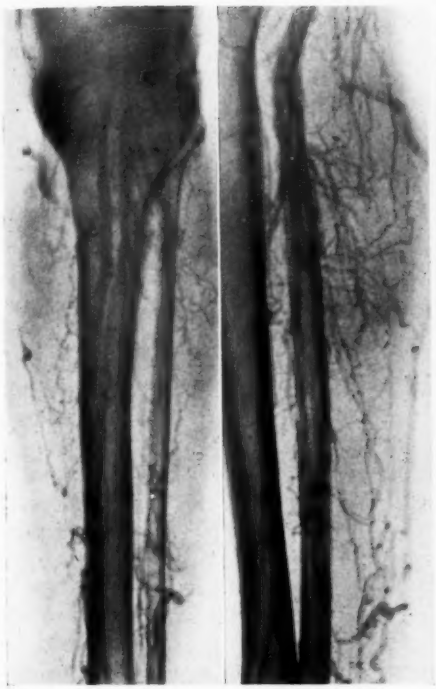


Fig. 8. Tilt phlebography of left lower leg. Same patient as in fig. 7. Irregular calibration and longitudinal muscular collaterals, as well as absence of any valvular pattern; there is a suggestion of a few valves in the anterior tibial vein, but they are not competent. (A. p. view II not shown for lack of space.)

Fig. 9. Tilt phlebography of left lower leg. Sequelae of deep thrombosis with slight recanalization and venous return through a superficial vein. Muscular collaterals in the calf, which, compared with those shown in fig. 8, form a more vague pattern but have a predominantly longitudinal course.

able results (cf. previous pressure measurements, MATHIESEN 1955). Fig. 6 illustrates incompetent communicating veins in the lower leg immediately above the internal malleolus.

Tilt phlebography and MASSELL & ETTINGER's method were compared in 7 cases, in 5 of which the latter method showed the 'false' incompetent communicators already mentioned. Disregarding these 'false' positives, a total of 24 incompetent communicators were identified by tilt phlebography and only 13 by MASSELL & ETTINGER's technique, *i. e.* 54 %. If only these authors' criteria for diagnosing incompetence were used, the values were somewhat higher, but the better peripheral filling obtained

by tilt phlebography indicated the presence of competent valves in the peripheral areas. Conformity between the two methods was found in only 2 cases, one of which exhibited no defective communicators by either method.

From our experiences in this small series, even more importance is now attached to the contrast medium in the second a. p. view having reached right out to the superficial venous system. From anatomic descriptions, *e. g.* RAIVIO, we know that a number of communicators have valves only just below or just above the fascia (cf. Fig. 4, a and b).

Sources of error. According to the principle of the method, there is no possibility of evaluating indirect communicators communicating with muscular veins with normal valves unless these muscular veins have filled during the injection proper. This is, however, of little significance since, from a functional point of view, defects in such communicators must be compensated for by the competent muscular veins.

Other sources of error are in my opinion of a purely technical nature. Too slow a rate of injection or a deficiency in an amount of contrast medium injected, may result from a bad venous puncture and produce poor filling of the deep veins; this occurred a few times in the first phlebographies. In a few cases the patient moved the leg during the investigation, despite instructions to the contrary; this twice interfered with the interpretation of the appearances. Another error, which occurred at the outset, was insufficient compression above the malleoli, so that the rapid injection also resulted in filling of the superficial system. If this filling is marked, the investigation has to be repeated. Insufficient compression in the groin is of course of no significance in cases with a negative Trendelenburg test as a primary phenomenon or following operation. This hardly ever involves any marked reflux of the contrast medium if a tourniquet has been applied. A source of error which has given rise to some difficulty, on the other hand, is undetected incompetence of the small saphenous vein. If this possibility is not borne in mind, reflux of the contrast medium in the small saphenous veins and its branches may create an illusion of incompetent communicators beneath the knee. This may be brought about if the films for the lateral views are placed incorrectly so that the posterior part of the poples are not included; it may then be difficult to identify possible incompetence of the small saphenous from the a. p. views alone.

Filling of the anterior tibial vein is no better with tilt phlebography than with any other phlebographic technique. Distinct filling was seen in only 57 % of 275 phlebographies. This is, however, mainly of theoretical interest, as incompetence of the communicators to this vein is extremely rare. As might be expected, the rate of the injection seems to influence

Fig. 10 Fig. 11

Figs. 10 and 11. Tilt phlebography of right lower leg. Spindle-shaped dilatation of the posterior tibial vein, and, respectively, retrograde filling of large muscular veins in the calf.

greatly the frequency with which such filling occurs. The author has carried out investigations in 7 patients, in the supine position, of the effect of varying the rate of the injection of contrast medium in the same extremity. Good filling, *i. e.* including filling of the anterior tibial vein, was obtained in all the cases when the injection rate was under 20 sec for the 40 ml and filling was often seen with the injection rate between 20 and 30 sec, but never when the injection was performed more slowly. Despite the small numbers involved, there appears to be justification for the statement that a rate of a maximum of 20 seconds for the injection of 40 ml under the conditions mentioned seems to secure optimal conditions for filling the anterior tibial vein. But even though the rate of injection was kept within these limits, filling of the anterior tibial vein was not obtained quite so often as in a larger series of tilt phlebography cases.

Sequelae of deep thrombosis involving recanalization do not prevent the phlebographic diagnosis of incompetent communicators. In the absence of any passage through the entire deep venous system, the question of penetration through the communicators is of course of no significance.

In a few cases with very large varices and numerous large incompetent communicating veins, there was such massive filling of the superficial venous system that it was difficult to observe detail. In such instances, the only resort seems to be to operate upon the definitely verified sites and then to repeat the investigation later.

Other phlebographic findings. Since tilt phlebography, both with and without the modification now described, presupposes filling of the deep veins, it can also give valuable information regarding their state. This applies primarily to the presence and functional capacity of the valves as already mentioned by DOHN. In order to diagnose sequelae of thrombosis, however, we demanded the following generally accepted criteria (cf. HØJENSGAARD, inter alios):

1. Absent or incomplete filling of the deep veins (except for the anterior tibial vein) and passage of the contrast medium through the superficial (subcutaneous) veins.
2. Absent, or possibly deficient pattern of the valves in the deep veins.
3. Irregular calibration of the deep veins and thin, net-shaped muscular collaterals.

Since the series consists predominantly of cases of chronic incompetence of the veins of the lower limbs, it includes only a few cases with absence of filling of the deep veins (1). All these patients had exhibited typical clinical signs of deep thrombosis. Out of the total series of 687 phlebographies, 31 presented the sequelae of deep thrombosis with recanalization of the veins.

It must be borne in mind that the pattern of the valves in the thigh veins varies somewhat, and even with the tilt technique it is somewhat less distinct than in the lower leg. This also applies to normal subjects.

Figs. 7 to 9 show some examples of phlebograms of cases with histories of thrombosis. The author, like previous workers, has in several cases seen competent valves in a few of the deep veins, indicating that only part of the venous system has been involved in the thrombosis.

'Spindle-shaped' dilatation of the deep veins of the calf was seen in a certain number of cases (Fig. 10). As the films were taken in two projections, it is evident that the spindle shape was not caused by compression of the vein by the pressure of the calf against the couch or merely by overlapping of other veins. These dilatations may be situated in the posterior tibial vein as well as in the fibular vein; there may be absence of distinct valve pattern in the dilated areas although as a rule the valves are found to be functioning normally.

a b c

Fig. 12. Tilt phlebography: a) of the right thigh, b) of right lower leg, and c) of left lower leg. Filling of the muscular collaterals in patients who had never exhibited clinical signs of deep thrombosis. Normal valvular pattern in the deep veins.

In a certain proportion of cases there may be filling of the large muscular veins in the calf, and it must be decided whether the filling is a retrograde phenomenon (Fig. 11); a so-called 'generalized ectasia' of the deep veins is distinctly outlined.

The material included many patients with histories of operation for varicose veins, and in some of these we noted phlebographic appearances which in their more marked forms appear to be characteristic and to command particular interest owing to their similarity to the signs of previous deep thrombosis. We refer to a number of relatively fine-calibred, more or less tortuous, deep-seated (muscular) collaterals with a predominantly longitudinal course. Muscular collaterals with less advanced changes are not infrequently present in patients with primary varicosities

without a history of deep thrombosis. They may co-exist with an indistinct valvular pattern in the deep veins, but the deep veins are always of regular calibre, and some competent valves may nearly always be identified (cf. Fig. 12). The degree of these changes in the phlebograms is extremely varied. In the most marked forms, the appearances approach those seen following clinically confirmed deep thrombosis, whereas the less advanced varieties form an even transition to normal phlebographic appearances.

In no case did there seem to be sufficient evidence for diagnosing an idiopathic absence of valves.

Variations in the presence and course of the deep veins are demonstrated in the same way as by other phlebographic techniques. The large transverse, often arched anastomoses which may be seen between the deep veins in the lower leg as well as in the thigh ordinarily produce an appearance quite different from that of the above-mentioned 'muscular collaterals'; the author interprets them as normal anatomic variations with no definite pathogenic significance.

Apart from the appearances following deep thrombosis, the clinical significance of the above-mentioned phlebographic findings is not yet clear. Some of the appearances may be seen in phlebograms of 'normal' legs (HØJENSGAARD 1951, GREITZ 1955). The author will endeavour to elucidate some of these problems in a subsequent study.

SUMMARY

The author describes a modified technique of tilt phlebography of the leg, for demonstrating incompetent communicators, which he has employed in 687 examinations of 470 cases. The general findings are discussed and special reference is made to appearances of the deep veins intermediate between the normal and those which follow clinically recognized deep thrombosis; these do not appear to have been described previously.

ZUSAMMENFASSUNG

Der Verfasser beschreibt eine modifizierte Technik der Wippenphlebographie der Extremitäten für Darstellung inkompetenter Kommunikanten, welche in 687 Untersuchungen bei 470 Patienten benutzt worden ist. Die allgemeinen Befunde werden besprochen; besonders aufmerksam gemacht wird auf das Auftreten tiefer intermediärer Venen zwischen normalen Gefässen und von Venen, welche nach einer klinisch manifesten Thrombose auftreten. Dieser Befund scheint bisher noch nicht beschrieben worden zu sein.

RÉSUMÉ

L'auteur décrit une technique modifiée de phlébographie sur table basculante du membre inférieur pour la mise en évidence des communicantes insuffisantes, qu'il a utilisée dans 687 examens de 470 cas. Il étudie les résultats d'ensemble et s'attache particulièrement aux aspects des veines profondes qui sont intermédiaires entre les aspects normaux et ceux qui sont consécutifs aux thromboses profondes cliniquement reconnues; ces aspects semblent ne pas avoir été décrits auparavant.

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CONGENITAL ANOMALIES OF THE SOUND-CONDUCTING ORGANS

by

Pekka Soila

Our knowledge of congenital malformations of the external and middle ear is largely based on MARX' (1926) description of 48 dissected cases in which 54 ears were affected. Their infrequent occurrence has caused these conditions to be rare objects for roentgen studies. Case reports presented may have included comments on the roentgen findings (HUME and OWENS 1935, WOLFRAM 1954, HENNER and BUCKINGHAM 1956) and tomography of the malformed external auditory canal was described by CAMP and ALLEN (1940), who stated that ossicles were not discernible in the tomograms obtained. In later tomographic studies the polycyclic method employed by FREY and MÜNDNICH (1957) showed good results also in congenital anomalies. Roentgenography of the auditory ossicles was described by SAMUEL and THERON (1952). The authors recommended submento-vertical and Towne's projections as most profitable; they included cases of congenital malformations.

MARX divided the malformations into four groups and pointed out the individual features and variations from case to case. HENNER and BUCKINGHAM divided congenital ear defects into three classes according to the degree of the abnormality and with due regard to the clinical con-

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dition of the patient. Surgical intervention to correct a unilateral malformation has been questioned, though some authors consider operation always indicated (DENECKE 1953). A roentgen examination is of help in clarifying the nature and extent of the deformity.

Material

This report is based on 74 cases, 50 being male and 24 female. Bilateral malformation was observed in 10 cases, 6 of which were male and 4 female. Thus 84 ears in all have been examined (Table 1). The youngest patient was 3 years of age, the oldest 62 years old and 53 patients were children, aged 14 years or less.

Table 1

Number of patients and ears (numbers within parentheses) examined

Sex	Right	Left	Bilateral	Total
♂	24	20	6 (12)	50 (56)
♀	15	5	4 (8)	24 (28)
Total	39	25	10 (20)	74 (84)

Bilateral axial views (submento-vertical projection) and lateral stereoscopic views with the tube tilted 30° cranially constituted the routine films. Various sagittal projections, *e.g.* those suggested by CHAUSSÉ, were occasionally used to complete the examination. Observations were made on the temporal bone as well as on the condition of the condyloid process of the mandible and the articular fossa.

Reports on operations (Prof. Yrjö Meurman) were available and were compared with the respective roentgen findings. With an exception of three ears, the purpose of the operation was to reach the tympanic cavity. In 9 cases the roentgen and operational findings were not in agreement. The total number of operations was 82.

Roentgen findings

In view of the individual variations in these cases the interpretation of the roentgenograms was confined to the condition of the tympanic cavity, the ossicles, and the external auditory canal. In order to present a coherent impression of the material, four different degrees of malformation are described, with random comments on other anatomic details.

The condition of the external auditory canal is fairly well determined from the submento-vertical view which may show various degrees of

Table 2

Results of observations on 70 examined ears in agreement with the operation report

Grade	I		II		III		IV	
Number of ears	15		12		35		8	
External auditory canal:								
Normal	—		—		—		—	
Hypoplastic	8		5		10		1	
Absent	7		7		25		7	
Condyloid process:								
Normal	11		7		12		1	
Deformed	4		5		23		7	
Articular fossa:								
Normal	11		8		24		1	
Hypoplastic	4		4		11		7	
Pneumatization:	Unobstructed	Obstructed	Unobstructed	Obstructed	Unobstructed	Obstructed	Unobstructed	Obstructed
Outside pyramid	5	1	4	1	8	4	—	—
In pyramid	2	5	1	3	5	9	—	—
Absent	—	2	—	3	—	9	—	8

shortening and narrowing; rounded translucencies are sometimes seen at its site. Complete absence of the canal may also be established, for which purpose the lateral views are most important. Roentgenograms of children — the majority of the patients examined — are particularly rewarding; the osseous structure is delicate, the air-containing cavities produce good contrast and the often disturbing styloid process is usually not well developed. From the operative point of view, the mastoid antrum should be demonstrated as precisely as possible. If the pneumatization of the bone is poor, the antrum and the adjoining aditus ad antrum often show distinct contours, or their absence may be determined with accuracy. An extensive, well-pneumatized cellular system is usually combined with minor anomalies, but may cause confusion in cases of marked anomalies.

The size, boundaries, and the air content of the tympanic cavity determine the results of evaluation of the ossicles. In a normal-sized, well-pneumatized cavity, the head of the malleus is seen as an oval, sharply defined opacity in the attic. The body of the incus appears with much less density; however, in a submento-vertical film this part of the incus and particularly its articular surface and the joint between the malleus and the incus can be demonstrated. These two ossicles are derived from the 1st visceral arch and their bodies are intimately connected so that malformations often result in an incu-malleolar bone with a more or less marked degree of deformity. The stapes has its origin in the 2nd arch, quite separate from the former bones and, being closely surrounded

Fig. 1. Bilateral involvement. Grade I deformity on left, Grade II on right side. Absence of any accompanying changes; only the external auditory canals are partly obstructed. At operation the ossicles were reported to be intact on the left side; on the right side the malleus was deformed.

by the lateral osseous wall of the internal ear, is not shown in the routine projections. The Eustachian tube is seen as a straight canal with well-defined borders which may guide the observer in a search for the deformed tympanic cavity.

The following roentgenologic division is suggested for the deformities. Four grades are employed.

Grade I. The tympanic cavity is of about normal size, sharply demarcated and contains air; the head of the malleus, the body of the incus, and the joint are discernible.

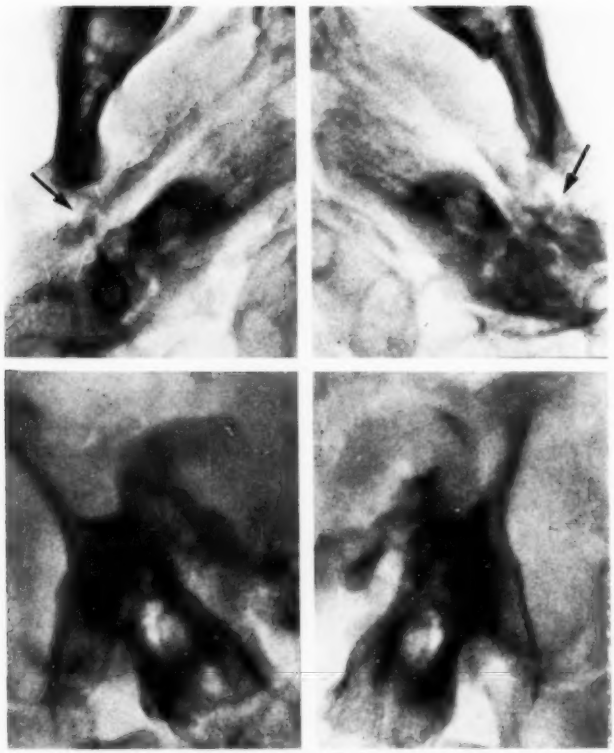

Fig. 2. Bilateral involvement. Incu-malleolar joint visible on both sides but at operation was found only on the right side. On the left side the tympanic cavity was faintly visible and no cell of any kind was present in the compact bone.

Grade II. The form, air content, and margins of the tympanic cavity may vary, but the head of the malleus is discernible.

Grade III. The ossicles form a conglomerate mass in a deformed tympanic cavity, and the malleolar head is not discernible.

Grade IV. Complete obstruction of the tympanic cavity combined with an absence of a cellular system.

Deformations of the temporo-mandibular joint comprise a hypoplastic appearance of the ramus, the collum and the capitulum, and a flattening of the fossa with poor definition of the contours. Various degrees of deformity as well as variations in the parts affected are encountered.

Pneumatization of the temporal bone varies considerably from case to case, excepting in the Grade IV cases, where no cells are discernible.

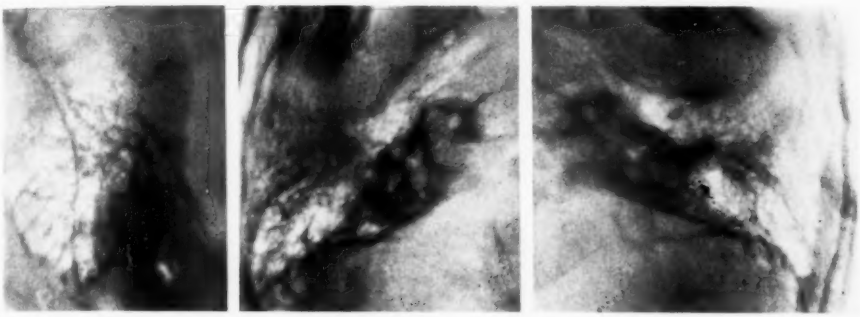

Fig. 3. Grade III deformity on right side. Head of malleus not visible. Unobstructed, delicate cellular system. At operation a deformed incus was found.

Errors and difficulties. In 3 of the unconfirmed 9 cases, the tympanic cavity was not reached at operation. No method to guide the surgeon in the deformed, poorly pneumatized bone has been devised, perhaps because these cases have been rare. A few attempts were made to introduce a lead ball into a drilled cavity, although with little success. It is felt that a system of co-ordinates, which would show in the films, might be developed to mark the tympanic cavity.

In 6 cases the presence of a tympanic cavity or a translucent canal representing the mastoid antrum was doubtful from the films. Subsequent operative exploration, however, progressed beyond a sizable antrum to a concise tympanum to reveal three separate ossicles in 4 cases and an incu-malleolar bone in 2 cases. A review of the roentgenograms suggested two different sources of error. The bone surrounding the air-containing cavities was either densely sclerotic and covered the moderately deformed middle ear (4 instances), or there was an abundance of well-developed cells producing such masking that the detail could not be properly defined (2 instances). Particularly in the former cases, tomography would obviously have been helpful in revealing the unobstructed cavities. On several occasions it was also noted that any non-osseous material situated in the middle ear considerably diminishes the contrast between the cavity and the surrounding bone. The head of the malleus may be discernible as a dense knob, indicating the presence of more or less organized ossicles, and should always be looked for at the site of the obstructed cavity.

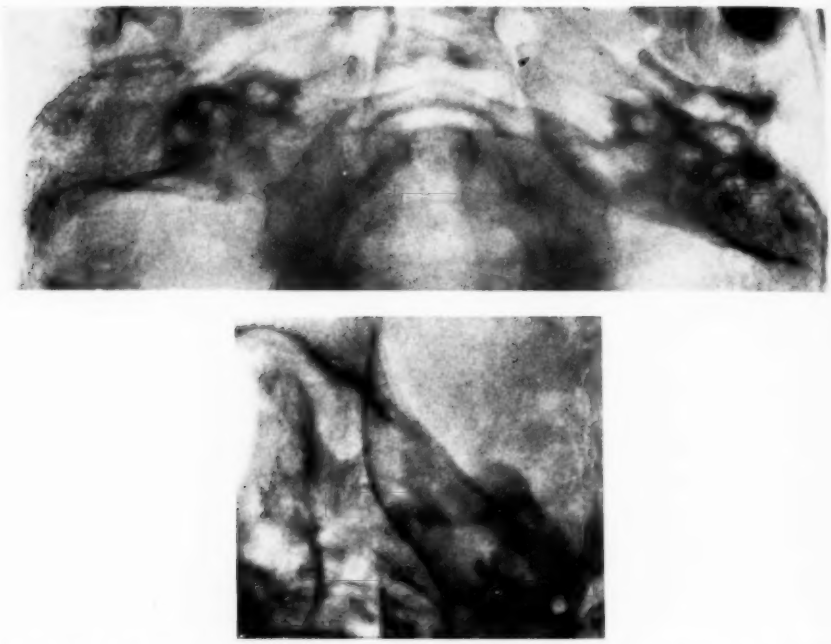

Fig. 4. Grade IV deformity of right side. Only the Eustachian tube visible. No elements of middle ear found at operation.

Results

Two of the 84 ears which were examined roentgenographically were not operated upon. On 3 occasions the purpose of the operation was a minor correction. In 9 cases there was disagreement between the roentgenologic and operative findings, as previously mentioned. The results of the 70 remaining examinations are presented in Table 2. One half, 35 ears, belong to Grade III, 8 ears, or about one in ten to Grade IV, and the rest being fairly evenly divided between Grades I and II. The external auditory canal was deformed or absent in every case, the degree of malformation obviously following that of the tympanic cavity. Deformations of the condyloid process and the temporo-mandibular fossa also followed the pattern of the middle ear, but pneumatization showed more variations. Only Grade IV ears displayed a consistent lack of cells.

In seven out of every eight cases it has been possible to determine the details of congenital malformations of sound-conducting organs at the roentgen examination. Any errors have been due to failure to show the tympanic cavity. A prominent feature of the malformation was

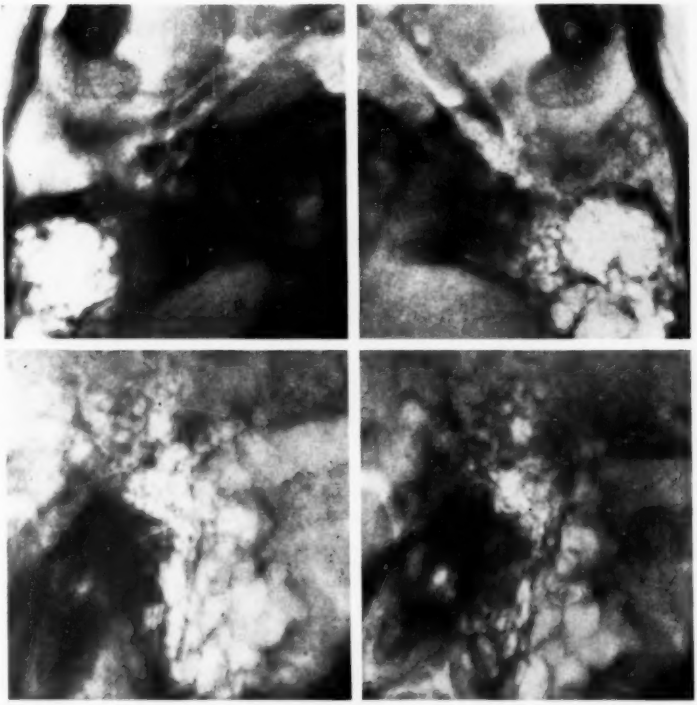

Fig. 5. Attic only vaguely discernible and overshadowed by the cells. Ossicles not discernible. At operation a fixed but well-formed malleus and normal incus with a functioning joint between them were found.

hypoplasia or absence of the external auditory canal. Deformations of the condyloid process and the temporo-mandibular fossa may also be evaluated and are found to increase with the degree of the middle ear anomaly.

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SUMMARY

Congenital anomalies of the sound-conducting organs are described in a material of 84 ears. A division into four grades according to the condition of the ossicles and the tympanic cavity is suggested. Malformations of the external auditory canal and the temporomandibular joint seem to follow the deformity of the middle ear. In 3 cases a tympanic cavity which had been demonstrated roentgenographically was not reached at operation, and in 6 cases the roentgen examination failed to reveal the cavity which was found later by the surgeon.

ZUSAMMENFASSUNG

Kongenitale Anomalien der tonleitenden Organe, die in einem Material von 84 Ohren vorkamen, werden beschrieben. Eine Einteilung in 4 Stadien unter Berücksichtigung des Zustandes der Gehörknöchelchen und der tympanitischen Hohlräume wird vorgeschlagen. Missbildungen des äusseren Gehörganges und des Kiefergelenkes scheinen der Deformierung des Mittelohres zu folgen. In 3 Fällen wurde ein tympanitischer Hohlraum, der röntgenologisch dargestellt worden war, bei der Operation nicht gefunden. In 6 Fällen missglückte die röntgenologische Entdeckung der Kavität, die später vom Chirurgen gefunden wurde.

RÉSUMÉ

L'auteur décrit sur une série de 84 oreilles les anomalies congénitales des organes de la conduction du son. Il propose une division en quatre degrés d'après l'état des osselets et de la cavité tympanique. Les malformations du conduit auditif externe et de l'articulation temporo-maxillaire paraissent liées à la malformation de l'oreille moyenne. Dans 3 cas, on n'a pas trouvé à l'operation une cavité tympanique mise en évidence radiographiquement et dans 6 cas l'examen radiographique n'avait pu montrer cette cavité qui a été, par la suite, trouvée par le chirurgien.

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UNE TECHNIQUE POUR L'ARTÉRIOGRAPHIE DE L'ARTÈRE CAROTIDE EXTERNE

par

Giovanni Ruggiero et *Maurice Jay*

S'il existe en littérature des observations sporadiques démontrant qu'une artériographie de l'artère carotide externe (a. c. e.) a été réalisée, il n'y a pas, à notre connaissance, de travail portant sur une série suffisante d'examens réussis volontairement. Or, cet examen peut être très utile. Ses principales indications sont les suivantes.

1. La démonstration de la participation des vaisseaux de la dure mère à la vascularisation d'un anévrisme artério-veineux intracranien.
2. L'étude de certaines tumeurs et malformations vasculaires extracraniennes avec ou sans prolongement intracranien.
3. La définition des contours d'un méningiome.
4. Le diagnostic différentiel entre un méningiome et une tumeur vasculaire intracérébrale.

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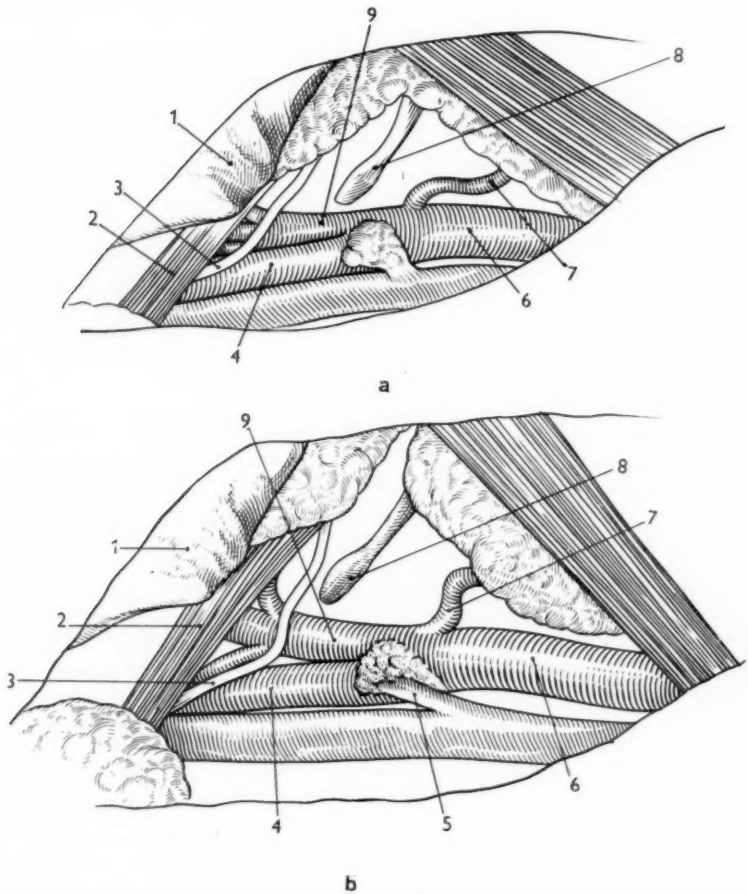

Fig. 1. Rapports entre les branches terminales de l'artère carotide primitive dans les différentes positions du cou et de la tête. a) Position normale pour l'artériographie carotidienne. L'artère carotide interne et l'artère carotide externe droites sont presque superposées après la bifurcation de l'artère carotide primitive. b) Position pour l'artériographie de l'artère carotide externe (cou défléchi, tête tournée vers la gauche); l'artère carotide interne et l'artère carotide externe se dégagent de façon très nette.
1 — angle du maxillaire inférieur. 2 — muscle digastrique. 3 — XIIe nerf cranien. 4 — artère carotide interne. 5 — tronc veineux thyro-linguo-facial entouré de graisse. 6 — artère carotide primitive. 7 — artère thyroïdienne superieure. 8 — grande corne de l'os hyoïde. 9 — artère carotide externe.

C'est cette dernière indication qui, à notre avis, est la plus importante. Cependant nous n'en ferons pas la démonstration, le but de ce travail se limitant à la description d'une technique.

Dans sa monographie classique sur l'artériographie, WICKBOM dit que si la ponction de l'artère "is made immediately below the bifurcation (which can often be palpated) it is often possible, by changing the direction of the needle, to steer the contrast to the external or to internal carotid". Nous avons essayé cette technique pendant longtemps avec un succès modéré. Un de ses inconvénients consiste dans le fait que souvent, en transperçant trop de fois les parois des vaisseaux, on provoque un hématome qui complique l'examen. Nous avons ensuite essayé une technique consistant à ponctionner avec deux aiguilles les deux artères (la carotide interne (a. c. i.) d'abord), méthode employée aussi par LINDGREN. De cette façon l'a. c. i. est pour ainsi dire fixée quand on essaie de ponctionner l'a. c. e. Cependant il nous arrivait souvent de ponctionner deux fois la même artère (en général l'a. c. i.) à des niveaux différents. Dans les mains de LINDGREN cela semble arriver assez rarement. Nous pensons que cette discordance est peut-être dûe au fait qu'il pratique cette méthode chaque fois que les clichés montrent que l'aiguille ne se trouve pas dans l'artère choisie, c'est-à-dire également dans les cas où, à l'occasion d'une artériographie de l'a. c. i. ou de l'artère carotide primitive (a. c. p.), l'a. c. e. est ponctionnée par erreur. (Dans notre expérience portant sur 1,130 artériographies carotidiennes la ponction involontaire de l'artère carotide externe nous est arrivée 44 fois.) Or, comme la ponction de l'a. c. i. est bien plus facile que celle de l'a. c. e. (dans les mêmes conditions) on comprend que dans ses cas un deuxième essai avec une autre aiguille permette facilement de ponctionner l'a. c. i. Par contre, comme nous n'utilisions la technique des deux aiguilles que pour la ponction volontaire de l'a. c. e. (dans les cas d'erreur nous préférions retirer l'aiguille et recommencer) cela explique peut-être le nombre assez élevé d'échecs. LINDGREN signale que l'a. c. e. peut être parfois très étroite et par conséquent difficile à ponctionner. Dans ces cas il a recours à une technique identique à celle décrite par WICKBOM. En tout cas, aucune de ces deux méthodes ne nous a donné, à nous, un pourcentage de succès supérieur à environ 30 % des cas.

Nous nous sommes donc penchés sur le problème d'un point de vue anatomique et nous avons recherché sur le cadavre s'il existait une position pouvant être considérée comme élective pour la ponction de l'a. c. e. Nos recherches nous ont montré que la position classique de l'artériographie, à savoir le malade allongé sur le dos avec le cou en déflexion, ne favorise pas la ponction de l'a. c. e. En effet, dans cette position (Fig. 1 a) les deux artères restent, après la bifurcation de l'a. c. p., très

a b

Fig. 2. Détermination du point d'élection pour la ponction de la carotide externe. Le point noir indique l'endroit où on palpe la corne de l'os hyoïde. a) Le cou est déflechi et la tête est dans l'axe du corps tandis qu'en (b) le cou est déflechi et la tête est tournéee vers le côté opposé. L'axe dans lequel doit être insérée l'aiguille est délimité par ce repère et l'angle du maxillaire inférieur bien visible en (b).

près l'une de l'autre, se superposant presque, de sorte que l'aiguille rencontre presque toujours forcément d'abord l'a. c. i. Par contre, dans une position de torsion et de déflexion du cou (Fig. 1 b) les deux artères se dégagent l'une de l'autre au maximum, l'a. c. e. devenant alors nettement antérieure à l'a. c. i. L'a. c. e. peut alors être repérée sur un axe allant du tubercule de la grande corne de l'os hyoïde jusqu'à l'angle du maxillaire inférieur. Comme, d'après les auteurs classiques, la bifurcation de l'a. c. p. se fait toujours en-dessous ou, au maximum, au niveau de la grande corne de l'os hyoïde, celle-ci peut donc être utilisée comme point de repère.

En pratique on procède de la façon suivante: on allonge le malade sur le dos, le cou étant droit et légèrement déflechi, et, dans cette position, on repère la corne de l'os hyoïde (Fig. 2 a). Ensuite on tourne le cou et on trace idéalement une ligne allant de ce point à l'angle du maxillaire inférieur (Fig. 2 b). On pique dans l'axe de cette ligne, quelques millimètres au-dessus du point de repère et, après avoir remis la tête à droite, on injecte le contraste.

Bien qu'ayant essayé cette technique dans un nombre limité de cas nous la présentons car nous avons été surpris par le résultat très favorable que nous avons constaté. En effet, sur 21 cas nous avons réussi assez facilement l'artériographie de l'a. c. e. 19 fois. (Au moment de la correction des épreuves nous avions pratiqué 35 autres artériographies de l'a. c. e. avec 1 échec, ce qui fait un total de 56 examens avec 3 échecs, ou un pourcentage de succès représentant 95 %.) Dans deux cas nous avons échoué: ces deux examens avaient été pratiqués sous anesthésie générale ce qui, à notre avis, est un élément défavorable. L'une de ces deux fois, l'examen fut interrompu après une seule tentative et remis à une date

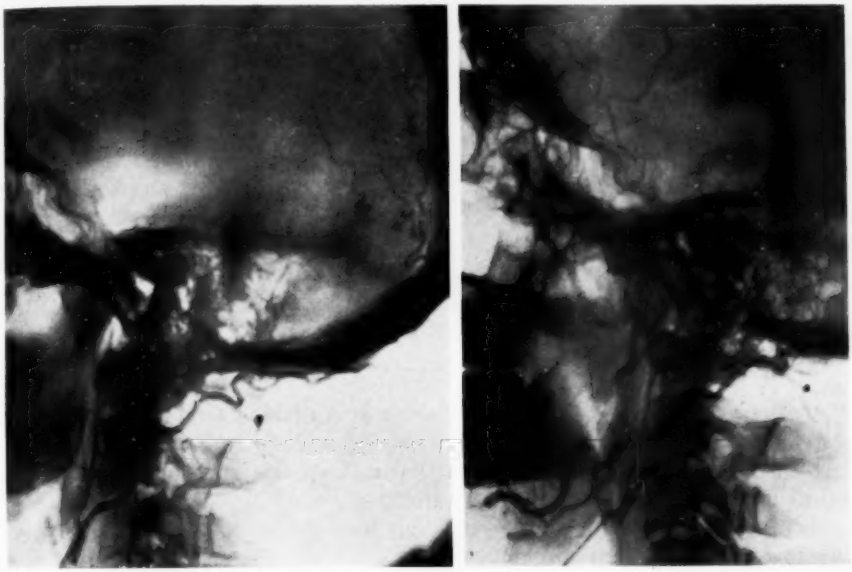

Fig. 3. Artériographie de l'artère carotide externe. L'aiguille qui était pénétrée directement dans l'artère occipitale put être ramenée, sans la retirer, dans l'artère carotide externe (b).

ultérieure pour ne pas prolonger la durée de l'anesthésie (on avait déjà pratiqué une artériographie vertébrale); l'examen fut répété quelques jours plus tard (toujours sous anesthésie générale) et réussit très facilement.

Voici maintenant un très bref exposé des principales difficultés de cette technique et des précautions qui nous semblent nécessaires pour les surmonter.

Position de la tête. On ne peut pas a priori établir le degré de torsion et de déflexion du cou car la position idéale varie selon les sujets. Elle est indiquée par le battement de l'artère qui, dans environ la moitié des cas est bien perceptible à la palpation. Quand celle-ci ne suffit pas, c'est la direction des battements de l'aiguille qui guidera l'opérateur.

Ponction. En piquant dans l'axe choisi il faut faire attention à ce que la ponction ne soit pas faite trop bas (car parfois la bifurcation de l'a. c. p. se situe juste au niveau de la corne de l'os hyoïde), ni trop haut (pour éviter de ponctionner une branche de l'a. c. e.). Dans un cas (Fig. 3) il nous est arrivé de ponctionner directement l'artère occipitale mais nous avons pu ramener l'aiguille, sans la retirer, dans l'a. c. e.

L'aiguille doit être dirigée presque perpendiculairement et légèrement vers l'intérieur. Il faut faire très attention à ne pas transpercer le larynx (ce qui nous est arrivé vraisemblablement une fois). Une fois l'aiguille enfoncée, si le sang ne s'écoule pas d'emblée, il ne faut la retirer que beaucoup plus lentement que pour l'artériographie de l'a. c. i. La tension dans l'a. c. e. est en effet en général plus faible et le sang remonte donc dans l'aiguille plus lentement. Ceci est encore plus marqué s'il s'agit d'une de ses branches. Dans ces cas, si on retire l'aiguille rapidement on peut même ne pas se rendre compte qu'une artère a été ponctionnée.

Il faut limiter au maximum les mouvements de la tête après la ponction. En effet, il est plus difficile de maintenir une aiguille dans l'a. c. e. que dans l'a. c. i., la cathétérisation étant plus difficile. Le risque que l'aiguille sorte est plus important.

Injection du contraste. Il faut injecter le contraste plus lentement que pour une artériographie de l'a. c. i. en raison de la tension diminuée, surtout pour éviter des reflux dans l'a. c. i. quand la ponction est faite immédiatement au-dessus de la bifurcation.

L'intervalle entre les différents clichés de la sériographie semble devoir être légèrement augmenté.

Anesthésie. La collaboration du malade est un facteur essentiel de réussite. Si après l'injection d'essai de 1 ou 2 ml de contraste le malade accuse une douleur marquée dans la bouche, la langue et les dents, la ponction de l'a. c. e. est certaine car, surtout avec des quantités de contraste aussi modérées, la ponction de l'a. c. p. ne saurait avoir le même effet.

Dans les cas où une anesthésie générale est indispensable il est indiqué de pratiquer la ponction le plus haut possible et surtout de commencer l'examen par la série de profil en ayant soin de bien mettre en évidence les vaisseaux du cou.

RÉSUMÉ

Description d'une technique pour l'artériographie percutanée de l'artère carotide externe.

SUMMARY

A technique for percutaneous arteriography of the external carotid artery is described.

ZUSAMMENFASSUNG

Eine Technik wird beschrieben für perkutane Arteriographie der A. carotis externa.

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PARTIAL ANOMALOUS PULMONARY VENOUS DRAINAGE

by

O. Fiandra, A. Barcia, R. Córtes, R. López Soto, J. Stanham and *M. Lombardero*

An abnormal connection of the pulmonary veins to some part of the systemic venous circulation draining oxygenated blood from the lung into the right auricle or main venous tributary creates a special hemodynamic condition. This condition is characterized by an increase in the output of the right ventricle to the detriment of that of the left. The abnormal venous connection may affect only some of the pulmonary veins (partial anomalous venous return) or all of them (total anomalous venous return). In the latter case the hemodynamic condition is totally different from the former because the systemic circulation is maintained due to the persistence of an interauricular communication that allows the arrival of a partially saturated mixture of blood to the left ventricle. The patients belonging to this group are therefore cyanotic.

The improvement in cardiac catheterization and selective angiocardiography now permits precise physiologic studies and correct anatomic diagnoses, and parallel to the extraordinary progress in cardiovascular surgery, has increased the interest that these malformations present. From the physiologic standpoint the increased filling of the right auricle may produce additional information regarding the mechanisms regulating the cardiac output. From the roentgenologic aspect the clear details

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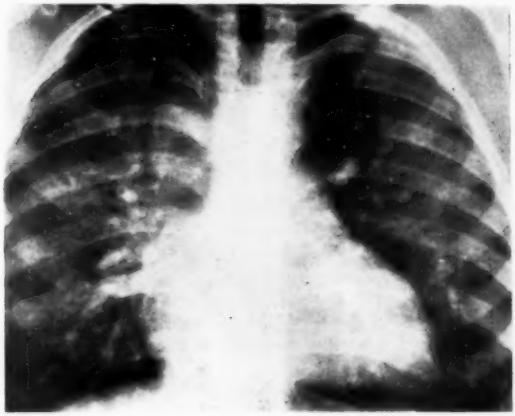

Fig. 1. Selective angiocardiography. Hypertrophic right ventricle. Dilatation of the pulmonary artery and its branches. In the venous return phase a thick venous trunk is seen arising from the inferior part of the left lung. The vessel pursues an ascending left paramediastinal course and drains into the superior vena cava, which appears greatly dilated.

shown by angiocardiography — especially when performed selectively — will permit a more precise anatomic diagnosis. From the surgical standpoint the better knowledge of the anatomic and hemodynamic alterations will permit of a more accurate assessment of the possibilities of surgical correction of these cases.

The following case is illustrative of the clinical, hemodynamic and roentgenologic problems of partial anomalous venous drainage.

Case report

Boy, aged 10 years, without symptoms, was sent to us for cardiovascular investigation. A widening of the superior mediastinum 4 years previously had been diagnosed as a mediastinal adenopathy and the patient treated for tuberculosis. The physical examination showed no signs of cardiovascular disease. Boy of normal development, slightly obese, with no evidence of chronic anoxemia. The chest was normally conformed; apex beat in usual situation. Slight proto and mid systolic murmur in the 2nd lumbar interspace at border of the sternum increased after exercise. B. P. 105/65. Brachial and femoral pulses synchronous.

Roentgen examination. Increased vascularity of the lungs with dilatation of the pulmonary artery, its two main branches and segmental arteries. Enlargement of the right side of heart. A cranial elongation of the arch of the atrium and exaggeration of its curvature with marked accentuation of the angle between the appendage and the atrium proper was noted. The right ventricle was also enlarged; apex rounded but not upturned. The left atrium and aorta were normal. The superior vena cava was seen to be

enlarged and a further density was present in the left lung just lateral to the pulmonary artery and the aorta and blending with the superior mediastinum.

The examination thus suggested a left to right shunt. The presence of a small left auricle excluded some of the shunts and suggested an auricular septal defect, an anomalous venous drainage, or a combination of the two. The dilated superior vena cava and the identification of an abnormal vessel in the left lung indicated an anomalous pulmonary venous drainage.

Electrocardiography showed an R S complex in VI and phonocardiography confirmed the auscultation: a 0.02 sec separation was noted between the aortic and pulmonary components of the 2nd sound in the 2nd lumbar interspace.

Catheterization performed through the right internal saphenous vein revealed a marked increase in the oxyhemoglobin saturation in the superior vena cava as compared with that of the inferior vena cava and both innominate veins. The oxygen saturation in the right auricle was the average of that of the two venae cavae. The catheter could not be passed into the left auricle in spite of a careful exploration of the interauricular septum; neither could it be introduced in the anomalous vein. The pressures in the right auricle, right ventricle, pulmonary artery and P. C. V. were normal.

For the calculation of the magnitude of the anomalous venous drainage the average between the saturation of the two innominate veins and the inferior vena cava was taken as the saturation of the mixture of the systemic venous blood. We use this average value because in our experience the saturation of the blood in the right auricle, in the absence of a shunt, is equal to the average of the saturation of the two venae cavae. It was presumed that the saturation in the anomalous vein was 100 %, which was the value of the saturation of the P. C. V. in that pulmonary lobe. The calculation revealed that 45 % of the right ventricle blood flow came from the anomalous vein.

The pulmonary blood flow as determined by Fick's method was 3,483 ml/min, with a cardiac index of 3,166. The systemic blood flow was 1,710 ml/min, with an index of 1,554.

Selective angiocardiography. The catheterization being completed, the tip of the catheter was placed in the pulmonary artery and selective angiocardiography was performed by the injection of 1.2 ml/kg body weight Rheopac 70 % with the patient under general anaesthesia. Simultaneous frontal and lateral films at the rate of two per second were obtained.

The right ventricle was dilated with hypertrophy of the crista supraventricularis and its bands. The pulmonary artery and its branches were also dilated.

The right superior and inferior and the left superior pulmonary veins were seen to drain into the left auricle in the venous return phase. A large venous trunk was noted running from the left lower zone and following an ascending left paramediastinal course outwards to the pulmonary artery and the aorta. It drained the innominate vein and finally emptied into the superior vena cava, which appeared greatly dilated. The left auricle, which appeared successively in diastole and systole, was normal in size. The left ventricle and the aorta were also normal.

The selective angiocardiography confirmed the suggestion of a partial anomalous pulmonary venous drainage of the left lower lobe into the superior vena cava.

Discussion

The case described is that of a boy without symptoms in whom a routine roentgen examination revealed a dilated superior vena cava and gave rise to an error in the original diagnosis. The case proved to be one of an

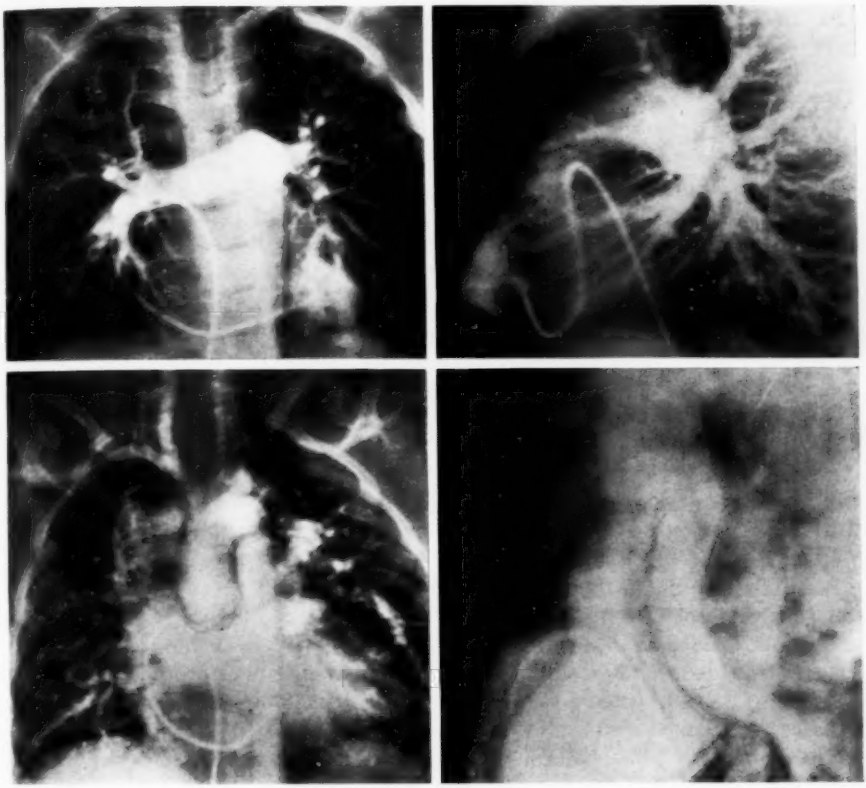

Fig. 2. Conventional roentgen films. Increased vascularity with dilatation of the pulmonary artery. Enlargement of right atrium and right ventricle. Unusual dilatation of superior vena cava.

anomalous pulmonary venous drainage with a venous return to the superior vena cava which formed 45 % of the flow of the pulmonary artery. In spite of the magnitude of this abnormal drainage, the only physical sign present was a murmur after exertion.

This feature agrees with what has been observed by other authors (9, 11, 13). We believe that it is because of this fact that many anomalous pulmonary venous drainages pass unnoticed and it is understandable that it was only in 1949 that DOTTER, HARDISTY and STEINBERG described the first two cases, these being supported by clinical and roentgenologic evidence. Up to then the findings in all the cases described were made at operation or post-mortem. A number of reports of cases in which the diagnosis was made in vivo have since been published (1, 3, 6, 9, 10,

12, 14, 15, 16). These diagnoses were made possible by catheterization and angiocardiography, by which this condition may be differentiated from other congenital heart lesions and its hemodynamic characteristics defined.

Certain embryologic factors must be appreciated in a consideration of the anomaly. According to EDWARDS, the primordia of the lungs, larynx and tracheobronchial tract, formed from the foregut, have their veins connected with the systemic veins (pre- and postcardinal) and the visceral veins (umbilicoviteline system), that is, with the veins which in the adult will constitute the superior vena cava, coronary sinus, innominate veins, proximal portion of the subclavian veins, portal vein, gastric veins, ductus venosus and inferior vena cava. An outpouching later develops from the left part of the sinu-atrial region, which will constitute the left auricle, and is known as the common pulmonary vein. This outpouching connects itself with the pulmonary capillary plexus; simultaneously the primitive connections of the pulmonary plexus regress, though some of them persist normally in the adult as small veins without functional importance but join the pulmonary circulation with the bronchial and portal circulations (with the latter through the oesophageal plexus).

The common pulmonary vein will later form part of the wall of the left auricle and its tributary trunks will constitute the pulmonary veins. The abnormal pulmonary venous connection will depend on the failure of the establishment of the connection between the common pulmonary vein and the pulmonary venous plexus or on the circumstance that once this connection is established it disappears later; in this way, the primitive connection persists and develops abnormally. As this development occurs before the diaphragm is formed, the abnormally persistent vein when directed to an abdominal vein will pass through the diaphragm through its own orifice or accompany the oesophagus.

In cases in which the abnormal venous connection is made into the right auricle near the septum, it is possible that the abnormality may have arisen in an abnormal development of the interatrial septum rather than in the abnormal persistence of a primitive venous connection.

Hemodynamic investigations in partial anomalous pulmonary venous drainage are recent and have been carried out in only a small number of the cases published to date (6, 10, 12, 15). Their interest is nevertheless considerable because they enable the physiopathological adaptations which are produced in these special cases of extracardiac shunts from left to right to be determined. It is possible that in the future the most accurate indications for surgical intervention will be provided by these studies.

The direct return of a part of the blood to the right auricle without

its having passed through the systemic circulation in this condition implies a rupture in the equilibrium that normally exists between the output of the two ventricles. The two outputs normally differ only by the small amount that returns from the coronary circulation to the left ventricle and from the bronchial circulation to the left auricle (venous admixture). The changes in the outputs demanded by the variations in body metabolism are therefore parallel in both ventricles.

All the factors which regulate the cardiac output are not known with exactitude, but the return of the blood to the right auricle has been cited as one of the more important. When a pulmonary vein drains abnormally into the systemic venous sector, the output of the right ventricle will increase. This is a condition, which of all those of left to right shunts, permits of the best study of the problem. This is brought about because a ventricular septal defect and a patent ductus arteriosus produce the shunt 'in front of' the right auricle and therefore the venous return to the right auricle is equal to the systemic output. The factors which regulate the cardiac output may thus be readily studied.

An auricular septal defect, which has been said to be a similar hemodynamic condition, does not allow the problem to be investigated so satisfactorily because the auricles form practically a common cavity and the shunt is determined fundamentally by the variable distensibility of the ventricles, that is, by functional factors (DEXTER).

It is of the utmost importance in making these determinations that the estimations of the cardiac output are more or less exact. An inherent error in our calculations not exceeding $\pm$ 150 ml/min, due to the method of the quantitative analysis, may be ignored.

In the case reported the output of the right ventricle was slightly increased and that of the left ventricle diminished. This decrease in the left ventricular output is rather strange and makes the existence of regulating factors of the cardiac output in the systemic sector independent of the blood return to the right auricle, appear doubtful.

In the cases reported in the literature no diagnostic problems existed. However, when the anomalous pulmonary venous drainage is made into the right auricle and an auricular septal defect is also present, the diagnostic problem may at times become insoluble. This is because the oxymetric patterns can be similar in both conditions although it does not imply that the hemodynamic pictures are the same in both cardiopathies, as has been stated. Irrespective of the atrial septal defects per se the shunt is larger and is conditioned upon functional factors dependent upon the auricles and ventricles, which are varying in time, and which may even cause an inversion of the shunt. This of course is not true in anomalous pulmonary venous drainage in which the anomalous blood flow is constant and is not influenced by the varying pressure gradients of the auricles.

An auricular septal defect may reasonably be excluded when careful exploration of the interauricular septum with the catheter inserted from below does not permit its passage into the left auricle. When the catheter passes into the left auricle the differentiation between an auricular septal defect and an anomalous pulmonary venous drainage with a patent foramen ovale may be made by means of the balloon catheter of Varnauskas-Jonsson. The balloon catheter may fail to show the auricular septal defect in cases of cribiform defects or when it has passed through a patent foramen ovale instead of through the defect. In cases in which an auricular septal defect is found, we know of no means of excluding an associated anomalous pulmonary venous drainage to the right auricle; only the surgeon will be able to determine the presence of these two anomalies during the operation for closure of the septal defect. If the balloon is made to tamponade the defect, a persistent admixture of blood indicates but does not prove an anomalous pulmonary venous return.

As to the treatment of the case reported we consider that as no symptoms are present there is no justification for the time being to try transplanting the anomalous vein to the left auricular appendage. This is in accord with the experience of RUNSTRÖM and SIGROTH who have found that the malformation is well tolerated when the shunt is under 50 %. We believe there is no indication for operation in cases without signs of right heart overload or systemic deficit. Nevertheless as an extensive lesion in the healthy lung can have a fatal outcome as in the case described by CONANT and KURLAND, an effective technique for anastomosing the pulmonary veins to the left auricle should be outlined and perfected in case similar cases be encountered in the future.

A separate study of the function of each lung was not made in our case. The investigations carried out by ARVIDSSON demonstrate that there exist differences between the healthy lung and the one abnormally drained. This study is of utmost importance if transplantation of the anomalous vein into the left auricle is considered feasible.

SUMMARY

A case of anomalous pulmonary venous drainage of the left lower pulmonary lobe into the superior vena cava, diagnosed roentgenologically, is reported. Hemodynamic factors are discussed.

ZUSAMMENFASSUNG

Die Verfasser berichten einen Fall mit anormaler venöser Drainage des linken Lungenunterlappens in die V. cava superior, welcher röntgenologisch studiert worden ist. Hämodynamische Betrachtungen werden angestellt.

RÉSUMÉ

Présentation d'un cas de drainage veineux pulmonaire anormal du lobe pulmonaire inférieur gauche dans la veine cave supérieure, étudié radiologiquement. Les auteurs font quelques considérations d'ordre hémodynamique.

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FROM THE RADIUM CENTRE (DIRECTOR: PROF. JENS NIELSEN), COPENHAGEN, DENMARK

ROENTGEN THERAPY IN HAND-SCHÜLLER-CHRISTIAN AND RELATED DISEASES

by

Bertel Jørgsholm

Hand-Schüller-Christian disease is a disease concept or rather a syndrome which began to be described between 1915 and 1928 (9, 21, 30, 39, 40, 41). In the classic descriptions it was reported to be characterized by translucencies of the cranial bones, exophthalmos, and diabetes insipidus. Later, it was realized that this combination of signs need not invariably be present and that other signs, such as cutaneous changes, anaemia, defects of other bones, and cerebral symptoms combined with one of the original cardinal signs, produced the same clinical syndrome.

This disease, which occurs predominantly in early childhood, seems to be on the borderline of neoplastic conditions. As yet, however, the aetiology and pathogenesis are not fully elucidated, although presumptions and discussions have not been wanting. There is little doubt, however, that there is a disturbance of the reticulo-endothelial system with an alteration of the lipid metabolism in the cells, possibly because of an enzymatic disorder. Whether these disturbances are of a neoplastic or inflammatory nature, we do not know. They result in the formation of tumour-like granulomatous or xanthomatous lesions which may be encountered at any site, but most often in the bones.

Hand-Schüller-Christian disease was first stated to be characterized by large, pale reticular cells and vacuolated histiocytes, the so-called foam cells which contain cholesterol, as well as by young connective tissue densely infiltrated with lymphocytes

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and leucocytes. The pathologic appearances have proved to be far from constant. They often consist of a motley and varying mixture of inflammatory and neoplastic changes which complicate the histologic classification. The initial stage may show nonspecific granulation tissue without accumulation of lipid in the reticulum cells, and there is frequently an abundance of eosinophils and sometimes of giant cells. In the peripheral blood there are no specific changes, and in most cases the blood cholesterol is not elevated.

The prognosis was previously considered serious, but the disease may vary from an almost acutely fatal course to more chronic, quiet varieties persisting for years. The younger the patient at the onset of the disease, the more malignant seems the course.

Two additional diseases were soon classified in the same group, viz. Letterer-Siwe's disease (31, 32, 42) and eosinophilic granuloma of bone (27, 28, 38). The symptoms and signs of these two diseases partially overlap, interfere with and supplement those of Hand-Schüller-Christian's disease clinically, radiologically, as well as pathologically. Letterer-Siwe's disease usually occurs at a somewhat earlier age (under 2 or 3 years), and in the classic description is characterized by generalized hyperplasia of the reticuloendothelial system with tumour-like proliferations of lymph nodes, bone marrow, spleen, liver and skin. The clinical manifestations are enlarged lymph nodes, spleen and liver, with destructions of bone, skin eruptions, anaemia and haemorrhagic diathesis. The course is frequently acute or subacute and the prognosis poor. Hyperplasia of the reticuloendothelial tissue with a mixed, often puzzling appearance is always present but there will often be numerous eosinophilic leucocytes and at times incipient accumulation of lipid in the reticular cells as in Hand-Schüller-Christian disease (50). These findings as well as the clinical picture have made more and more authors incline to the view that Letterer-Siwe disease is interpretable as a phase of Hand-Schüller-Christian disease or as its initial stage. Owing to the acute or subacute course, the patients seldom live long enough to develop the more prolonged course which is typical of classic Hand-Schüller-Christian disease, but there is no doubt that such a transition exists.

The third disease of the group, eosinophilic granuloma of bone, usually affects somewhat older children, setting in at the age of 5 or 6 years, but it has also been observed in adults. It manifests itself by solitary or sometimes multiple osteolytic changes, often of successive onset, causing mild swelling and tenderness around the affected bony regions. It is sometimes also accompanied by skin eruptions, but as a rule there are no generalized symptoms or effects on the general health. The course is benign, sometimes leading to spontaneous cure.

On pathologic examination, the granulation tissue is found to consist chiefly of reticular cells and accumulations of eosinophilic leucocytes, histiocytes, and frequently giant cells. But in this condition too, the appearances may be mixed and impossible to distinguish from the other two.

Hence, in broad features all the evidence at hand seems to indicate that the three conditions are manifestations of different phases or different varities of the same disease, the course of which depends, among other factors, on the age at which it occurs (7, 13, 33).

Histologically, there seem to be four distinct phases. The first is a hyperplastic, proliferative, reticulohistiocytic phase. The second is a granulomatous one with eosinophils, macrophages, and giant cells. The third phase is a xanthomatous phase predominated by accumulation of lipid, and the fourth is a fibrous phase of healing. However, this histologic classification is far from always in harmony with the clinical picture and course. The different histologic phases are frequently even encountered at the same time in the same patient.

Finally, it should be mentioned that without doubt some of these diseases have previously been confused with and classified as Ewing's tumour, reticulosarcoma, etc. Not knowing the clinical symptoms and course, it would seem to be sometimes difficult for the pathologist to give an exact primary diagnosis.

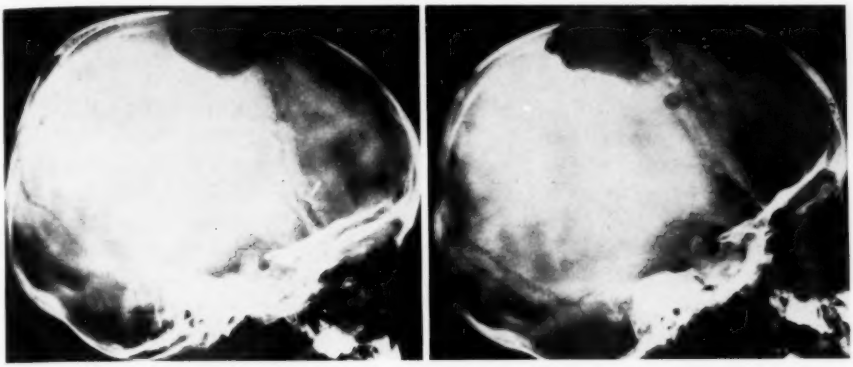
Author's material

Since 1933 a total of 14 patients suffering from these disorders have been treated at the Radium Centre. Six were girls and eight boys, ranging in age from 1 to 8 years. In 10 cases the clinical diagnosis was Hand-Schüller-Christian disease, in 2 cases Letterer-Siwe disease, and in 2 cases eosinophilic granuloma. All the characteristic signs were present, but scattered among all the cases. For instance, skin manifestations were present in 3 cases with Hand-Schüller Christian disease and in 2 with Letterer-Siwe disease. Exophthalmos was observed in 3 cases and diabetes insipidus in 4 of Hand-Schüller-Christian disease. Psychic changes, resulting in feeble-mindedness occurred in 2 patients with Hand-Schüller-Christian disease, although possibly extremely intensive radiotherapy was responsible. In addition to the signs mentioned above, one of the patients with Letterer-Siwe disease presented initial signs suggesting otitis media with destruction of bone and granulation-like tissue in the ear. This is mentioned, because it is an initial sign which is mentioned relatively often in other reports. On the whole, the bones of the temporo-parietal region quite often seem to be the site of predilection (7, 18).

Enlargement of the liver and spleen occurred only during the terminal stage in a fatal case of Letterer-Siwe disease.

The radiologic signs vary from a few bony translucencies, appearing at the same time or successively, to innumerable lesions in all parts of the skeletal system, but predominantly in the skull. As seen from the table it is difficult to distinguish histologically between the three diseases. Thus, in this material diagnosis varied, within all three, according to the juncture at which it has been made and from which site the biopsy was derived. This is more than ever evident from one of the cases in which a lymph node biopsy showed Letterer-Siwe disease; a simultaneous biopsy from granulation tissue in the ear showed eosinophilic granuloma, whereas the histologic diagnosis post-mortem was Hand-Schüller-Christian disease. The histologic diagnosis has frequently to be considered very carefully and a primary diagnosis of Ewing's tumour or a sarcoma-like tumour is by no means uncommon.

The duration of the disease ranged from 6 to 12 months to several years, the course being usually uniform, but in some cases intermittent. As mentioned above, however, the youngest patients show a more subacute, fulminant course. The bony changes sometimes seem to occur in bouts or waves, interrupted by partial, spontaneous remissions. Apart from one patient, who died at the end of 2 years, all our patients have survived. Four still have diabetes insipidus, and two of them are feeble-minded. Otherwise, all four are free from signs. The time of observation has been from one to 20 years.



a b

c

Illustrative examples of osteolytic changes in the skull of a patient with Hand-Schüller-Christian disease.

b) 6 weeks after the first course of treatment, the changes are more marked.

c) 3 years later the osteolytic changes have almost healed.

Treatment

The treatment of these diseases has been, and still is, purely roentgenologic (1, 7, 8, 19, 20, 25, 37, 43, 44) apart from solitary eosinophilic granulomas which are sometimes treated surgically. During roentgen therapy the bone lesions often disappear or regress, but as the disease is frequently prolonged, with partial remissions, it is difficult to evaluate the therapeutic effect. The skeletal changes appear often to increase immediately after the irradiation, before healing begins.

On the assumption that the diseases are of a malignant progressive nature, supported by an occasional histologic report of a sarcoma-like tumour, patients with these diseases have previously been treated in

Table

Roentgen treatment of 14 patients with Hand-Schüller-Christian and related diseases

Case No.	Treatments	Fields	Doses per field	Series dose per field	Total dose per field	Total dose/days
1	2	10	100 r	200 r	200— 400 r	2,200 r/120
2*	7	18	50—150 r	200—2,150 r	425—3,675 r	10,250 r/2,280
3	3	4	75—200 r	300— 600 r	300—1,100 r	2,200 r/610
4	2	4	100—125 r	125— 500 r	125— 500 r	1.200 r/210
5	2	12	25— 50 r	75— 300 r	75— 300 r	2,150 r/180
6	2	34	25— 50 r	50— 300 r	75— 300 r	4,450 r/381
7**	5	9	?	540—1,440 r	720—5,320 r	17,940 r/730
8	2	8	25—100 r	75— 400 r	75— 400 r	1,575 r/184
9**	2	10	25—100 r	75—1,400 r	75—1,400 r	5,150 r/665
10	2	10	5— 30 r	5 (universal)-570 r	5—1,045 r	2,580 r/286
11	3	11	5— 15 r	120— 195 r	120— 380 r	2,480 r/313
12	3	6	10— 40 r	40— 600 r	40— 640 r	990 r/545
13	1	2	25— 50 r	325 r	325 r	650 r/ 22
14	2	3	25 r	25— 50 r	25— 50 r	100 r/140

Quality of radiation: 180 kV. • 5 Cu, Th., 6—12 mA, 40 to 50 cm. Doses measured in air.

* First supposed to be Ewing's tumour.
** Part of treatment given in another hospital.

some clinics with heavy, sometimes cancerocidal doses in repeated series but without particularly encouraging results, the disease often being fatal. The contribution of the heavy doses to the fatal course is difficult to estimate, but experience from the Radium Centre indicates that far more is gained by careful, prolonged irradiation in small doses.

In most of our cases, we have used extremely cautiously fractionated roentgen irradiation in single doses ranging from 5 to 100 r (a few minor fields, however, receiving 125 to 200 r). (See table.) — The total dose to the individual fields has usually varied from 50 to 600 r, exceeding 1.000 r only in a few fields. Two patients, however, had considerably higher doses to the skull. One of them received prolonged fractionated roentgen irradiation to the right temple (a total of 3.675 r), as the primary diagnosis was Ewing's tumour. The other had received heavy repeated doses of roentgen rays to the skull prior to his admission. (Total dose to the skull exceeded 10.000 r distributed over several fields and courses.) Both these patients were mentally retarded and have later been declared feeble-minded. The first patient also had disseminated infiltrations in both lungs which, however, disappeared within a few months without treatment.

Diabetes insipidus developed in 4 cases. In one it set in during treatment with ACTH administered before admission to the Radium Centre. Incidentally, the hormone proved ineffective, and the patient's condition even deteriorated during the treatment. Out of the other three patients with diabetes insipidus, one had received small doses to the skull, and developed diabetes insipidus one year after the treatment was instituted. The remaining two are identical with the two patients who had received heavy irradiation to the skull. Diabetes in these cases developed 18 months and 2 years respectively after the commencement of irradiation. These few examples, however, do not permit any definite conclusion regarding a causal relationship. On the other hand, it does not seem possible as a rule to arrest incipient diabetes insipidus by irradiation, although some authors have reported success in single cases (25, 44). Incidentally diabetes is the only persisting sign in some of the patients who are constantly treated with posterior pituitary 'snuff'.

Conclusions

Our experience in this series appears to show that the cautious use of roentgen irradiation, so far the only effective form of treatment, produces equally good, and probably better, results than the heavy irradiation which has been used in some clinics.

It is impossible to rule out the influence of irradiation with low doses due to the tendency to spontaneous remission which is undoubtedly present in these lesions.

Acknowledgement

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SUMMARY

The author points out the similarity of the symptoms and signs in Hand-Schüller-Christian disease, Letterer-Siwe disease, and eosinophilic granuloma of bone and the likelihood that these three conditions are different phases of the same disease. Fourteen cases of these conditions have been treated, nearly all of them by small fractionated doses as opposed to the heavy irradiation. The results are analysed and discussed.

ZUSAMMENFASSUNG

Die Verfasser heben die Ähnlichkeit der Symptome bei der Hand-Schüller-Christian'schen Krankheit, der Letterer-Siwe'schen Krankheit und der eosinophilen Knochengranulome hervor und betonen die Wahrscheinlichkeit, dass diese 3 Zustände verschiedene Phasen einer Krankheit seien. Vierzehn Fälle dieser Erkrankungen sind behandelt worden, nahezu alle mit niedrigen fraktionierten und nicht mit grossen Strahlendosen. Die Ergebnissen werden analysiert und besprochen.

RÉSUMÉ

L'auteur souligne l'analogie des signes fonctionnels et physiques de la maladie de Hand-Schüller-Christian, de la maladie de Letterer-Siwe et du granulome éosinophilique de l'os; il est vraisemblable que ces trois affections sont des stades différents de la même maladie. Quatorze cas de ces affections ont été traités, presque tous par de petites doses fractionnées et non par une forte irradiation. L'auteur analyse et discute les résultats.

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RADIATION DOSE MEASUREMENTS AND LEUCOCYTE COUNT IN RABBITS

by

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The biological effects of ionizing radiation are conceivably dependent on both the dose and the time during which that particular dose is delivered, and whether the dose is given as a single or many irradiations. When the distribution of the dose with regard to time is unknown, or is difficult to evaluate, one usually defines the radiation data as a cumulated dose over a certain period, *e. g.* as the weekly dose. Similarly, the regulations for persons occupied in radiological work are mostly based on the concept of a highest permissible weekly dose. Calculations based on the week as a unit time are conventional, however, and it may be that a correlation of, for instance, blood values to another time unit is biologically more relevant.

In an earlier publication (1) some results from an investigation on the relationship between the frequency of certain changes in the blood picture of persons in radiological work and the estimated irradiation data were published. It appeared that when correlating the blood changes to the weekly dose the significance was not impressive (the correlation

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coefficient = 0.56), whereas the significance was successively strengthened when correlating these changes to the dose summed up during the times of 1,000, 10 and 0.1 seconds. The correlation coefficient was then raised to 0.77, 0.92 and 0.97, respectively. This would seem to imply that when we consider a certain type of radiation effect, *e. g.* blood changes, it may be possible to find such a time which gives the best correlation between effect and dose per time. This will be designated 'the biological relevant time'.

It was demonstrated (2) that the results are generally inconsistent when changes in the blood picture are correlated to a dose delivered during a span of time which appreciably exceeds the biological relevant time. It was also suggested that it should be possible to determine the biological relevant time experimentally or, at least, to enclose it within certain limits. Groups of animals should be given different doses according to the following general schedule. Two separate irradiation times should be selected, the one expected to fall below, the other above the biological relevant time. When the irradiation times are prescribed, the dose remains the only variable. The dose dependence of the biological effect would then show up in the 'short time' as well as in the 'long time' irradiated material. When a recalculation is made to longer (shorter) times than the relevant one the effect in the short time irradiated material would successively be greater (less) than the effect in the long time irradiated material.

The experimental data of the whole material will be expected to coincide, however, only when recalculated to the biological relevant time.

Materials and Methods

Male rabbits, weighing about 2.3 kg at the start of the investigations, were used. Two series of experiments were performed in the years 1954 and 1955. The doses were delivered as whole body irradiation at 60 to 80 kV tube voltage. The animals were tied during the irradiation in a special device turning the ventral side towards the roentgen beam. In order to facilitate the irradiations with widely different doses, primary as well as secondary radiation was used. Through suitable combinations of voltage and filter, roentgen beams of a relatively uniform quality could be obtained. The shortest irradiation time, 0.001 sec, was accomplished by the aid of a special rapidly movable slit.

The animals were divided into 9 groups of 10 animals each in the 1954-year investigation. Three groups, Nos. 2, 4, and 6 were irradiated for 10,000 seconds with doses of 1, 10^2 and 10^4 mr. Three groups, Nos. 3, 5, and 7 were given doses of 10^{-4}, 10^{-2} and 1 mr in 10^{-3} seconds. Group No. 1 was irradiated for 0.1 sec and given 10^2 mr, and group No. 8 was given 10^4 mr in 100 seconds. One control group, 0, had sham irradiation only, but was otherwise treated as the actually irradiated animals.

In this first year's series the animals had a slight infection of coccidiosis immediately after the pre-irradiation observations were started and a sulpha treatment was given to all animals. Although the irradiations were not commenced until the infection had sub-

sided, and although the technic described eliminates animals which in the sense stated below may have an abnormal blood picture at the start of the irradiations, we considered it advisable to perform a complementary experiment the next year. These are the groups 08 and 8. One control group (08) containing 11 rabbits had sham irradiation whereas the second group (8) of 10 rabbits had 10 mr in 0.1 seconds. It was found that the results in this small series agreed with those of the previous year. In all instances the irradiations were repeated once a week. The background dose was found to be 2.3 mr/week.

Before the irradiations were started, blood samples were drawn from all rabbits once a week for two months. Similarly, after the first irradiation one or two samples/week were attained during a period of two months. The days for radiation and blood sampling were chosen by permutation in such a way that the lapse of time between any irradiation and the consecutive blood sampling was always varied in the same way in all groups.

The blood samples were analysed for haemoglobin value, number of red and white cells, relative occurrence (200 cell counts) of segmented and stab neutrophile leucocytes, eosinophile and basophile leucocytes, as well as for lymphocytes and monocytes. Moreover, we assayed for hypersegmented neutrophiles and pathologic lymphocytes. Planned thrombocyte counts could not be carried out.

Results

A conventional statistical treatment of the material failed. Neither a study of the mean blood values in the different animal groups nor a study of the distribution of the white cell values of each group indicated any causality in the relation between effect and irradiation. To substantiate this statement we have in Table 1 given the total white counts in the groups.

One of the present authors (3) has, however, called attention to a 'read-off method' which seems to be adequate in the present case where the animals display great variations in their blood values. In the present work we have applied the method on the total white cell counts only.

The essential procedures of this read-off method are as follows. Each animal is followed with regard to its blood values for a fairly long period before the actual experiments began. The blood values are plotted (abscissa) on 'probability paper' against their cumulative probability (ordinate). If the values form a normal probability curve (within a few per cent a straight line on the probability paper) the animal in question is accepted as a useful experimental object, otherwise it is rejected. The number of animals approved as 'accepted' in each group is found in Table 2.

After the irradiation (or sham irradiation) the blood values from each 'accepted' animal are plotted on probability paper. If the values from the pre- and post-irradiation are still on a straight line the animal is classified as not affected by the irradiation.

If, however, this statistical treatment yields a broken line it may be inferred that the initial (normal) distribution of blood counts was altered by irradiation. The frequency within each group of such distorted distri-

Table 1 *Results of leucocyte counts*

Group	Before (b) and after (a) irradiation	Number of leucocyte counts	Thousands of leucocytes per mm³		Thousands of			
					< 5	5 to 6.9	7 to 8.9	9 to 10.9
			Mean	Median	Percentage distribution			
0	b	75	9.9	9.3	2.7	18.7	22.7	21.4
	a	110	9.9	9.6	1.8	9.1	28.2	30.0
1	b	88	9.5	9.0	10.2	18.2	19.3	22.7
	a	120	10.9	10.8	2.5	9.2	16.7	23.3
2	b	84	10.8	10.0	—	11.9	25.0	21.4
	a	130	11.9	11.7	0.8	13.1	10.0	18.5
3	b	83	10.5	9.0	3.6	15.7	31.3	18.1
	a	123	9.8	9.3	—	10.6	30.9	30.9
4	b	92	11.1	10.5	9.8	9.8	12.0	22.8
	a	140	13.4	12.4	—	0.7	9.3	25.0
5	b	89	10.4	8.6	4.5	18.0	28.1	22.5
	a	139	9.7	8.7	0.7	17.3	32.4	22.3
6	b	97	13.8	12.7	—	2.1	12.4	18.6
	a	130	12.8	11.7	—	3.1	16.2	23.1
7	b	82	10.0	9.5	2.4	14.6	20.7	25.6
	a	130	10.7	10.3	0.8	6.2	18.5	33.2
8	b	90	10.8	10.3	1.1	13.4	17.8	25.6
	a	130	10.3	9.7	1.5	7.7	28.5	23.1
OS	b	81	9.2	8.8	—	11.1	44.5	27.2
	a	175	8.9	8.7	1.1	12.0	42.9	29.1
S	b	80	8.3	8.3	1.3	20.0	45.0	25.0
	a	159	8.0	7.9	3.1	25.8	44.6	21.4

Table 2 *Irradiation data and percentage (B) affected animals*

Group	Notations Diagram 4	Irradiation conditions		mr summed			
		mr	time	10^{-3} sec	10^{-2} sec	10^{-1} sec	1 sec
0	○	2.3*	one week	$3.8 \cdot 10^{-9}$	$3.8 \cdot 10^{-8}$	$3.8 \cdot 10^{-7}$	$3.8 \cdot 10^{-6}$
1	◑	10^2	10^{-1} sec	1	10	10^2	10^2
2	⊙	1	10^1 sec	10^{-7}	10^{-6}	10^{-5}	10^{-4}
3	●	10^{-4}	10^{-3} sec	10^{-4}	10^{-4}	10^{-4}	10^{-4}
4	⊙	10^2	10^1 sec	10^{-5}	10^{-4}	10^{-3}	10^{-2}
5	●	10^{-2}	10^{-3} sec	10^{-2}	10^{-2}	10^{-2}	10^{-2}
6	⊙	10^1	10^1 sec	10^{-3}	10^{-2}	10^{-1}	1
7	●	1	10^{-3} sec	1	1	1	1
8	⊗	10^1	10^2 sec	10^{-1}	1	10	10^2
OS	○	2.3*	one week	$3.8 \cdot 10^{-9}$	$3.8 \cdot 10^{-8}$	$3.8 \cdot 10^{-7}$	$3.8 \cdot 10^{-6}$
S	◑	10	10^{-1} sec	10^{-1}	1	10	10

(⊗ ◑ denotes points which coincide) * Natural radiation only.

leucocytes per mm³							
11 to 12.9	13 to 14.9	15 to 16.9	17 to 18.9	19 to 20.9	21 to 24.9	25 to 29.9	≧ 30
of leucocyte counts							
20.0	5.3	8.0	—	—	1.3	—	—
19.1	8.2	2.7	0.9	—	—	—	—
12.5	11.4	1.1	3.4	—	1.1	—	—
24.2	12.5	8.3	1.7	0.8	—	0.8	—
23.8	7.1	6.0	—	1.2	1.2	2.4	—
20.0	15.4	10.8	6.2	3.9	1.5	—	—
10.9	6.0	4.8	2.4	2.4	2.4	2.4	—
15.4	7.3	2.4	2.4	—	—	—	—
16.3	14.1	3.3	4.4	3.3	4.4	—	—
20.0	20.0	4.3	7.1	8.6	2.9	0.7	1.4
7.9	5.6	4.5	2.3	2.2	2.2	1.1	1.1
11.8	13.7	1.4	1.4	—	—	—	—
18.6	15.5	13.4	4.1	5.2	9.3	—	1.0
12.3	16.2	11.6	9.2	3.9	4.6	—	—
17.1	12.2	4.9	1.2	1.2	—	—	—
23.1	12.3	2.3	3.1	—	0.8	—	—
20.0	10.0	3.3	5.6	2.2	1.1	—	—
22.3	10.0	4.6	1.5	—	0.8	—	—
14.8	1.2	—	—	—	—	—	1.2
10.3	4.0	—	0.6	—	—	—	—
7.5	1.3	—	—	—	—	—	—
5.0	—	—	—	—	—	—	—

up** during					Accepted animals	Affected animals	B %
10 sec	10^{2} sec	10^{3} sec	10^{4} sec	one week			
$3.8 \cdot 10^{-5}$	$3.8 \cdot 10^{-4}$	$3.8 \cdot 10^{-3}$	$3.8 \cdot 10^{-2}$	2.3	5	0	0
10^{2}	10^{2}	10^{2}	10^{2}	10^{2}	6	4	66.7
10^{-3}	10^{-2}	10^{-1}	1	3.3	5	1	20.0
$1.4 \cdot 10^{-4}$	$4.8 \cdot 10^{-4}$	$3.9 \cdot 10^{-3}$	$3.8 \cdot 10^{-2}$	2.3	4	2	50.0
10^{-1}	1	10	10^{2}	10^{2}	5	3	60.0
10^{-2}	10^{-2}	$1.4 \cdot 10^{-2}$	$4.8 \cdot 10^{-2}$	2.3	6	4	66.7
10	10^{2}	10^{2}	10^{4}	10^{4}	5	3	60.0
1	1	1	1	3.3	6	5	83.4
10^{2}	10^{4}	10^{4}	10^{4}	10^{4}	6	5	83.4
$3.8 \cdot 10^{-5}$	$3.8 \cdot 10^{-4}$	$3.8 \cdot 10^{-3}$	$3.8 \cdot 10^{-2}$	2.3	6	1	16.7
10	10	10	10	12	8	6	75.0

** Natural radiation included when amounting to more than 10 % of the administrated doses.

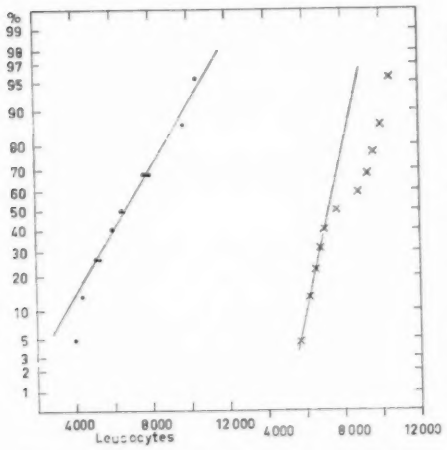

Diagram 1. Pre-irradiation for an accepted animal (●) and a not accepted animal (x). Ordinate axis: Cumulative probability in per cent.

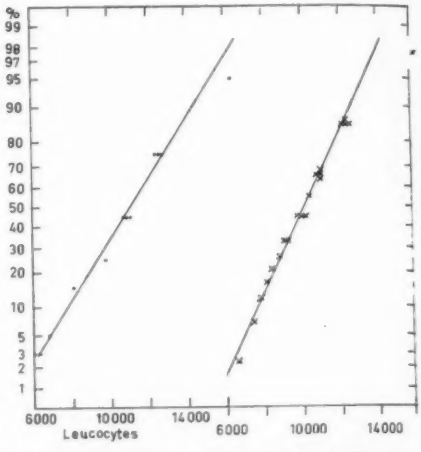

Diagram 2. Sham irradiated animal. 'Pre-irradiation' values (left, ●) and total values ('pre- and post-irradiation', x). Ordinate axis: Cumulative probability in per cent.

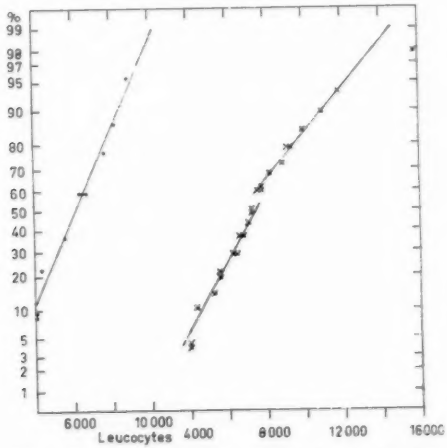

Diagram 3. Irradiated animal. Pre-irradiation values (left, ●) and total values (pre- and post-irradiation, x). Ordinate axis: Cumulative probability in per cent.

Table 3

Reference time	$p_{.001}$	$p_{0.1}$	p_{100}	P %
0.001 sec	5/8	1	1	63
0.01 »	5/28	1	1	18
0.1 »	1/14	1	1	7
1 »	1/84	1	1	1.2
10 »	1/84	1/2	1	0.6
100 »	1/165	1/3	1	0.2
1,000 »	1/165	1/6	1	0.1
10,000 »	1/165	1/6	1/2	0.05

bution curves is then a certain measure of the radiation effect. In Diagram 1 examples are given of accepted and not-accepted animals as evaluated by the present method. Diagram 2 shows a representative example of an accepted animal being sham irradiated after the initial observation period and thereafter followed for another two-month period. Since the pre- and the post-irradiation values belong to the same distribution, this animal's blood values were not significantly changed. If this type of curve is obtained in an irradiated rabbit, that animal must also be classified as not affected. Typical diagrams from an animal which has been actually irradiated and which displays a positive reaction are shown in Diagram 3.

In conformity with this definition of the biological irradiation effect we must consider the frequency of animals within each group which show deviations from the normal pre-irradiation distribution. This frequency is denoted *B* in the following treatment. (Cp. Table 2 and Diagram 4.)

In the semi-logarithmic diagrams (Diagram 4) the values for B are plotted against 'dose per unit time' where the time unit selected is 10^{-3} sec, 10^{-2} sec .... one week. It was found that when the time selected is 10^{-3} sec one obtains a simple relationship between the biological and the irradiation values, whereas the configuration becomes more and more distorted under the assumption of longer biological relevant times.

Since the biological effect is correlated with the dose rate rather than with the total dose administered, there arises the possibility of doses which differ very much having the same biological effect. If, for example, irradiation times of 10^{-3} sec and 1 sec were used to deliver doses of 10^{-3} mr and 1 mr, respectively, the dose rate in each case would be 10^{-3} mr/10^{-3} sec and the same biological effect would be expected. It should, however, be noted from our experiments that the shortest time used, 10^{-3} sec, does not exclude the possibility of a still lower relevant biological time unit.

In the diagrams we have also plotted the distribution which should have occurred if the relevant time had been 10^{-3} sec and if the experi-

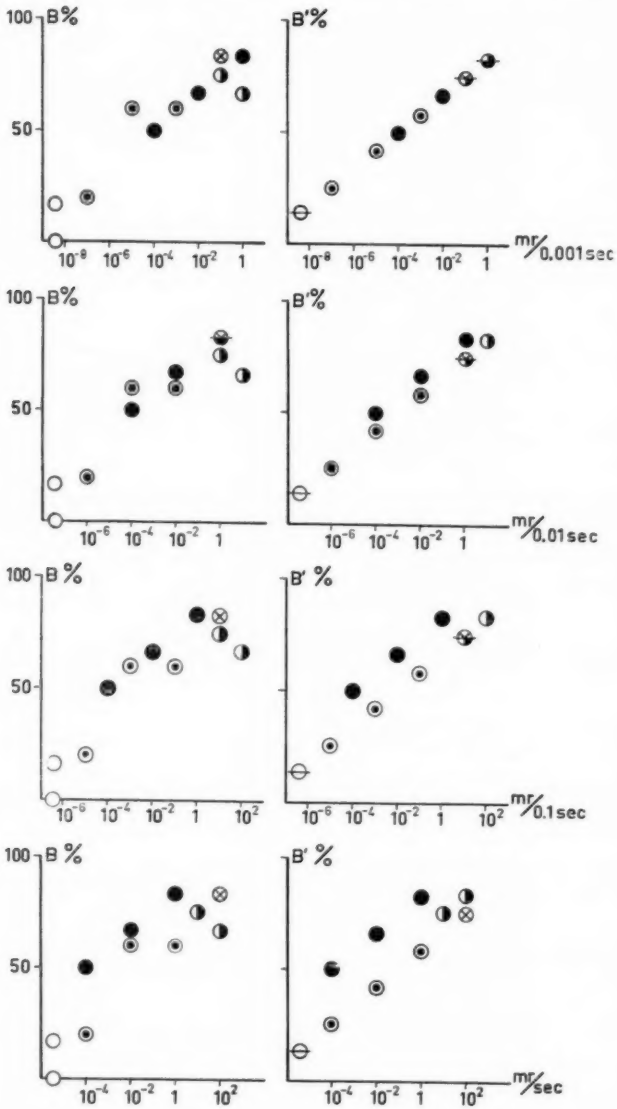

Diagram 4. Frequency of affected animals in the actual experiments (B). Calculated frequency assuming a strict validity of a relevant biological time of 10^{-3} sec (B'). Notations as given in Table 2. (Continuation of this diagram on opposite page.)

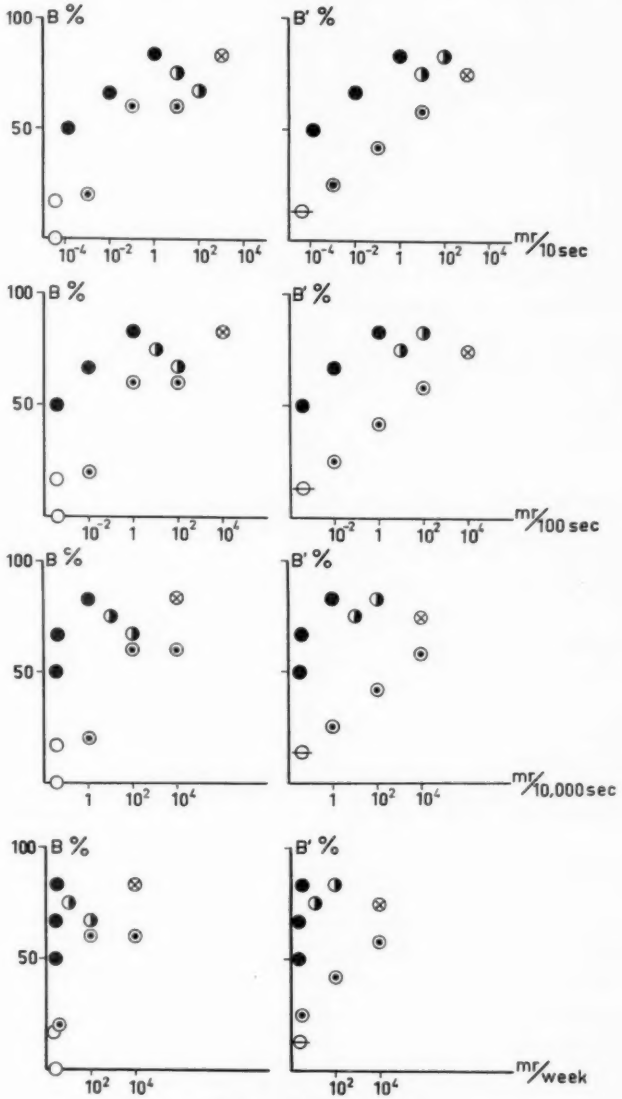

Diagram 4 (continuation).

mental material had been so great that statistical variations in B could be disregarded. This distribution, B', shows a very good coincidence with the B distribution actually found.

Discussion

In order to test the probability for the results in Diagram 4 to have occurred by chance instead of being the expression of a biological orderliness the following calculations were made.

The probability that from a group of a points, representing a certain irradiation time, together with b other points belonging to another group in regard to irradiation time should all fall above c points also belonging to the last mentioned b group, is:

$$P = \frac{(a + b)!\ (b + c)!}{b!\ (a + b + c)!}$$

Here, in b and c are counted all the points which are within the same interval of the abscissa as the a-points. In the group b, points to the left of this interval are also counted, provided they have an equal or higher ordinate value than the lowest a-point. Similarly, in group c, points to the right of this interval are also counted provided they have the same or a lower ordinate value than the highest a-point.

If we denote by $p_{0.001}$ this probability for the points representing the irradiation time 10^{-3} sec, by $p_{0.1}$ for 0.1 sec, except for the 10^{-3} sec-points, and by p_{100}, correspondingly in regard to the 100 sec-point, one has the probability that the results have occurred by chance:

$$P = p_{0.001} \times p_{0.1} \times p_{100}$$

In Table 3, p. 483 we have given $p_{0.001}$, $p_{0.1}$, p_{100} and P for different reference times.

Still another possibility of testing the significance of the results emerges from the following considerations. Let us consider the null hypothesis that the mode of distribution of the dose within the week were of no consequence. It then appears that the lowest and the highest weekly doses for the groups 0, 0S, 2, 3, 5, and 7 do not differ significantly (2.3 to 3.3 mr, Table 2). Considered from the point of view of a weekly dose these groups must be regarded as a very homogenous population. If we instead consider the millisecond dose, it is possible to divide the material roughly in two classes, C_1 with the groups 0, 0S and 2, and C_2 with the remaining

Table 4

Statistical treatment of the results applying the null hypothesis

Class	Rabbits with affected blood picture		Rabbits with non-affected blood picture		Σ
	Expected*	Found	Expected*	Found	
C_1 (groups 0, 08, 2) low millisecond dose; weekly dose 2.3 to 3.3 mr..	$\frac{13}{32} \times 16 = 6.5$	2	$\frac{19}{32} \times 16 = 9.5$	14	16
C_2 (groups 3, 5, 7) high millisecond dose; weekly dose 2.3 to 3.3 mr ..	$\frac{13}{32} \times 16 = 6.5$	11	$\frac{19}{32} \times 16 = 9.5$	5	16
Σ	(13)	13	(19)	19	32

* Assuming the null hypothesis to be true.

three groups 3, 5, and 7. None of the C_2 groups has had less than 1,000 times the millisecond dose given in class C_1.

Within the two classes the corresponding differences are not so marked; in C_1 the highest and the lowest millisecond doses do not deviate by more than about a factor of 5 from the geometrical mean of the class C_1 and the corresponding deviation in class C_2 is 10^2. As compared to that the geometrical means of the classes C_1 and C_2 differ by a factor of about 10^6.

All these data have been collected in Table 4. The calculations thus give the expected number of rabbits if the null hypothesis were correct, *i. e.* that the millisecond dose had been of no biological consequence in this actual experiment.

When applying Yates' correction because of a small number of observations we have from the Table 4:

$$\chi^2 = \frac{(2.5—6.5)^2}{6.5} + \frac{(13.5—9.5)^2}{9.5} + \frac{(10.5—6.5)^2}{6.5} + \frac{(5.5—9.5)^2}{9.5} = 8.29$$

and $0.01 > P > 0.001$. There is thus a high probability that the appearance of the blood changes under discussion in some way depend on the millisecond dose.

In an earlier publication (2) it was stressed that apparent contradictions which arise in an experimental material may be resolved when short time doses and not weekly doses are considered. In the present material, classes C_1 and C_2, for example, show frequencies of blood changes which deviate by a factor of 5 even though the weekly dose is practically the same. On the other hand, the groups of class C_2 have about the same frequencies of abnormal blood values as groups 6 and 8 although the class C_2 groups have had a weekly dose amounting to only about 1/3,000 of

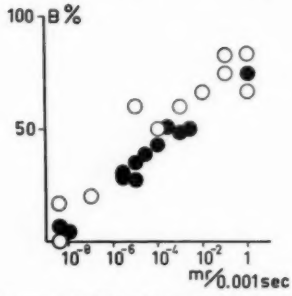

Diagram 5. Plot of human data from earlier work (●) and the present experimental material (○).

that of groups 6 and 8. All this is easily accounted for when millisecond doses instead of weekly doses are considered.

In the earlier work already referred to, some observations in human subjects were published and discussed (1, 2). We have for comparison plotted this material together with the present experimental results (Diagram 5). The coincidence between the two groups of observations is noteworthy. We believe this to be an indication that in both instances the best correlation between irradiation data and biological effect (*i. e.* the blood value changes in the actual case) is obtained when the irradiation data are calculated in dose quantity per very short time.

Since 'the biological relevant time' is evidently very short, it seems to us more appropriate to speak about a dose-rate effect rather than a dose effect.

We should also like to call attention to certain similarities between our results and those recently published by SUTTON and ROTBLAT (4). These authors were able to show that the chemical transformation after the irradiation of an aqueous solution of certain inorganic salts was independent of the administered dose but highly dependent upon the dose rate. In these radiochemical reactions the critical dose rates were, however, much higher than in our biological material, viz. of the order of 10^8 to 10^{10} rads/sec.

Acknowledgement

The present work was made possible through generous grants from the Royal Swedish Medical Board, Swedish Defence Medical Research Committee, the Swedish Atomic Committee and from an anonymous donor.

Part of this work was performed at the State Bacteriological Institute, where Professors G. OLIN and S. GARD kindly put animal rooms and other facilities at our disposal.

SUMMARY

The changes in the leucocyte counts in rabbits as a function of the irradiation data seem to verify observations in human subjects. In both instances the frequency of the observed changes was found to be primarily related to the dose-rate, *i. e.* mr per (very short) unit time of irradiation rather than to the total dose administered. This very short unit time has been designated 'the biological relevant time'.

ZUSAMMENFASSUNG

Die Veränderungen des weissen Blutbildes bei Kaninchen als eine Funktion der Bestrahlungsdaten scheinen die bei Menschen gemachten Observationen zu bestätigen. In beiden Fällen fand man, dass die Häufigkeit der beobachteten Veränderungen hauptsächlich eher zu der Dosisleistung, d. h. mr pro Bestrahlungszeiteinheit (sehr kurz) in Beziehung zu setzen ist als zu der gegebenen Totaldosis. Diese sehr kurze Zeiteinheit ist als »die biologische Relevanszeit« bezeichnet worden.

RÉSUMÉ

Les modifications de la numération leucocytaire chez des lapins en fonction des facteurs d'irradiation semblent confirmer les observations faites sur l'homme. Dans les deux cas on a constaté que la fréquence des modifications observées est en rapport direct avec le débit de dose, c'est-à-dire le nombre de mr par (très courte) unité de temps d'irradiation, plutôt qu'avec la dose totale administrée. Cette très courte unité de temps a été appelée «le temps biologique adéquat».

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BOOK REVIEWS

EXPERIMENTAL STUDIES ON RADIOACTIVE ZINC IN THE MALE REPRODUCTIVE ORGANS OF THE RAT. By Bengt Wetterdal. 83 pages, 37 illustrations and 4 tables. Acta radiol. Suppl. 156 (1958). Sw. Kr. 30: —.

Recent observations have revealed an especially large content of zinc in the prostate and spermatozoa of rats. Considerable pathologic changes have been found to occur in the male reproductive organs in experimental animals fed on a diet deficient in zinc.

These observations inspired the author to study the uptake and localization of zinc administered in the male reproductive organs. The radioisotope tracer techniques were used and albino rats were chosen as experimental animals. The problems of whether the spermatozoa take up administered radioactive zinc as they lie in the testis and the epididymis and where such an eventual uptake occurs were also subjected to studies.

Zn^{65} solutions with a specific activity of 0.047 to 0.183 mC/mg Zn were used and administered intramuscularly in adult male rats. These were sacrifized at different times, from 1 to 62 days, after the injection. The reproductive organs — the testis, the epididymis, the vas deferens, the dorsolateral prostate, the ventral prostate, the coagulating gland and the seminal vesicle — were subjected to scintillation measurements by standard experimental techniques. The uptake of Zn^{65} in the organs studied was expressed as a concentration of the amount of Zn^{65} injected per g rat. Concentration curves related to the time after the administration of Zn^{65} were found to differ considerably for the organs studied.

A unilateral surgical separation of the vasa efferentia between the testis and the epididymis was performed in some animals. The operation was found to prevent spermatozoa in the testis from reaching the epididymis without causing any tissue changes in the epididymis. The concentration of Zn^{65} in the caput and cauda epididymis which were separately investigated were found to differ considerably on the operated and non-operated sides. The differences in the concentration of Zn^{65} in the epididymal parts on the two sides seemed to be due to the number of spermatozoa present in the epididymal ducts.

The localization of Zn^{65} in the tissues of the reproductive organs were studied by means of autoradiography. The apposition technique was used. Gevaert No-screen roentgen films and Agfa Printon R films were used. The exposure times for these films were two and three months, respectively. Satisfactory reproductions of the autoradiograms were obtained on Ultrahard Gevaert bromide paper when magnified 5 times. Agfa Printon R film autoradiograms were capable of being magnified about 40 times.

Different errors in the techniques used in autoradiography as well as in the scintillation measurements were subjected to investigations.

The autoradiographic studies were performed at different times after the Zn^{65} injection. The autoradiograms were found to vary at the different times investigated, especially those of the testis, the epididymis and the vas deferens. The secretion of the dorsolateral prostate, the ventral prostate, the coagulating gland and the seminal vesicle was shown to take up administered Zn^{65} quite differently. Within the dorsolateral prostate the lateral parts were found to take up considerably more Zn^{65} than the medial part.

The results obtained were used as an attempt to estimate the time of passage for the sperm transport as Zn^{65} seemed to be taken up in the spermatozoa in the seminiferous tubuli of the testis and to be firmly attached to them during their transport into the ejaculate.

The concentration of administered Zn^{65} in the organs studied was found to be related to the content of zinc that earlier had been determined to occur in these organs.

The observations obtained indicate that the spermatozoa take up zinc in the seminiferous tubuli of the testis and with a relatively large content of zinc are carried through the sperm transport system to the ejaculate. They will here meet an additional amount of zinc derived mainly from the secretion of the dorsolateral prostate.

Autoreview

THE HEAD AND NECK IN ROENTGEN DIAGNOSIS. By E. PENDERGRASS, J. P. SCHAEFFER, and P. J. HODES. 1,984 pages, 2,403 illustrations. Charles C. Thomas, Springfield 1956. U. S. doll. 37.50.

This book may be said to belong to the classics of the roentgen literature; it is well known to most roentgenologists, particularly those interested in the skull. More experience has been gained and new methods introduced, or old ones improved, since the first edition appeared some fifteen years ago, and there are therefore good reasons to welcome a new edition which according to the preface is 'in part rewritten and rearranged, at places greatly extended, and new sections added'. It is now of double size and has been divided into two volumes.

Whatever arrangement is chosen it is of great importance that a book of this size be set out with suitable and well-defined divisions and subdivisions. Numerous headings are employed but they do not seem to be particularly well selected. The anatomy is described in detail and often augmented by a short review of the embryology. A brief review of the physiology is also included, as for example in the chapter on the pituitary gland. Practically every lesion which may produce roentgenologically demonstrable changes in the skull or neck are discussed. The nose and paranasal sinuses, the mastoid and the petrous bone, the jaws and teeth, as well as the orbit, are each dealt with in special chapters. The clinical signs in the various conditions discussed are given considerable and sometimes unduly great prominence. The clinical syndromes in certain rare conditions are described in detail but the somewhat atypical roentgenologic findings only briefly. The differential diagnosis between similar roentgenologic changes but caused by different lesions does not appear, on the other hand, always to be given due consideration. Similar appearances in the bone structure in tumours, inflammatory processes, and metabolic disturbances are described but the possibility of differentiating them roentgenologically is hardly mentioned. Changes in the sella turcica produced by an intra- or a suprasellar tumour, by a dilated third ventricle, or by increased intracranial pressure without hydrocephalus, are not properly defined.

The chapter on pneumography is hardly worthy of recommendation. The importance of maintaining the spinal fluid pressure during the procedure is mentioned and attention is drawn to LINDGREN's 'excellent paper' on the encephalographic technique. Nevertheless the authors employ one which is almost at complete variance with it. The method used by the authors is in the reviewer's opinion inadequate, and it is not difficult to understand why encephalography is said to be restricted to cases in which there is no or little reason to suspect a tumour. For a satisfactory examination of the ventricular system it is of course essential that films be taken in at least two projections, preferably at right angles to each other, and with the head in the same position. The distribution of the gas

and fluid will otherwise be altered between the two films, a point which the authors do not seem to have fully realized. The technique for the proper examination of the temporal horns is hardly dealt with at all. Changes in the ventricular system caused by tumours are described mainly in connection with ventriculography. For some unknown reason, however, certain tumours, *e. g.* intraventricular dermoids and tumours deforming the temporal horn, are dealt with in the section on encephalography. Among the ordinary signs of small parietal tumours, the one first mentioned is dilatation of the whole ventricular system, the other is 'occasional encroachment upon the anterior horns of both lateral ventricles' — statements which make one doubtful as regards the authors' ability to diagnose small lesions by means of pneumography. The accuracy of the pneumographic method is not discussed but without comment the authors give Moore's figures of only 65 % focal accuracy as compared to 92 % when radio-active isotopes are used. The authors seem to be unaware of the fact that an accuracy of about 95 % is obtainable with a proper encephalographic technique.

The descriptions of opto-chiasmatic arachnoiditis and of herniation of the ventricles occupy almost the same space as that devoted to growths, and the case reports and reproductions covering these conditions are more numerous than those illustrating the latter. Rare lesions, and lesions of limited practical interest, are given more attention than the more common and important ones, in other parts of the book as well. As an example may be mentioned that several pages are devoted to fractures of the inferior concha, the vomer, and the lacrimal bones, but the important fractures of the middle ear, mastoid, and petrous bone, are hardly mentioned.

The majority of the illustrations are of good quality and the changes they purport to show are in most cases obvious. Some of the reproductions from other papers or lent by colleagues are, however, not up to standard. The interpretation in some cases, as far as can be judged, also appears to be incorrect. Many of the legends to the illustrations are voluminous and contain a mass of clinical data much of which is scarcely relevant; at the same time any note on confirmation at operation or autopsy is often conspicuous by its absence.

In spite of all this adverse criticism a great deal could be said to the credit of this comprehensive work. The reader will be able to find much useful information on practically every lesion of roentgenologic interest which may affect the skull or neck. In the reviewer's opinion the careful and detailed descriptions of the anatomy and embryologic development of the various structures are perhaps the most valuable in the whole volume. A roentgenologist will certainly be thankful over and over again to have this book on his shelves when he encounters a difficult problem in routine as well as in research work.

Ingmar Wickbom

LA PNEUMOPELVIGRAFIA NELLA DIAGNOSI DEI TUMORI GINECOLOGICI (Pneumopelvigraphy in the diagnosis of neoplasms in gynecology). Del G. Carnevali, U. Lucarelli e P. Paracchi. 196 pages, 64 illustrations. Casa Editrice Renzo Cortina, Pavia 1957.

The technique of pneumopelvigraphy is described in detail and attention is given to the roentgenographic anatomy. Neoplasms of the uterus, tubes and ovaries are discussed and the elements on which a pneumopelvigraphic diagnosis can be based are well illustrated. A chapter is devoted to pneumopelvigraphy in cases of pelvic metastases. A survey of the literature is included.

Francesco S. Tolone